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BOTANICAL GAZETTE

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UNDESCRIBED PLANTS FROM GUATEMALA AND OTHER CENTRAL AMERICAN REPUBLICS. XX.

JOHN DONNELL SMITH.

(WITH PLATE XII)

Theobroma simiarum Donn. Sm.— Folia obovato-oblonga cuspidata ad basin cordatam 3-nervia dentato-repanda supra glabra subtus subcanescentia et in nervatione fusco-pilosa. Inflorescentia e trunco prorumpens fasciculata intricato-ramosa multiflora. Ligulae jam in aestivatione reflexae cucullo vix bis longiores obovatae retusae in unguem gracilem attenuatae staminodiis obovato-lanceolatis paulo breviores dimidio angustiores. Stamina triantherifera. Fructus elliptico-cylindraceus coriaceo-cartilagineus exangulatus exrugosus.

A lofty tree with spreading branches, younger parts and inflorescence tomentose. Stipules linear-lanceolate, plurinerved, about 2^{cm} long. Leaves coriaceous, $3–4^{dm} \times 14–19^{cm}$, strongly reticulated, midrib and lateral nerves prominent beneath; petioles stout, about 12^{mm} long. Cymes subsessile, axes woody, pedicels bibracteolate in middle. Calyx tomentose, partite nearly to base; segments reflexed, 10×6^{mm}, acute, furnished within at base with yellow and minutely oblong glands. *Cuculli* glabrous, oval, 6^{mm} long, 5-nerved; *ligulae* glabrous, with claw 5^{mm} long added 10^{mm} long, at rounded apex 4^{mm} broad. Staminal tube naked, 2^{mm} high, equaling the free part of filaments; staminodes erect, glabrous, exunguiculate, 13^{mm} long, at base 2^{mm} broad. Styles distinct nearly to base, twice longer than globose and tomentose ovary. Fruit $24–26^{cm}$ long, $8.5–9^{cm}$ in diameter, rounded at apex, more obtuse at base, fusco-farinose, surface uniformly even; seeds

about 45, compressed-globose, about 2^{cm} in diameter.— Differs from other many-flowered species by conspicuously petaloid staminodes, and from all congeners by the elongated fruit, of which the surface is neither angled, ribbed nor excavate.— Popular name *Cacao de Mono.*

Hacienda de La Concepcion, Llanuras de Santa Clara, Costa Rica, alt. 200^{m}, Feb. 1896, *Donn. Sm.*, no. 6457 Pl. Guat. etc., qu. ed. Donn. Sm.— Térraba, C. R., alt. 260^{m}, Feb. 1891, *Pittier & Tonduz*, no. 3925 herb. nat. C. R.— Forests of Boruca, C. R., alt. 466^{m}, Mch. 1892, *Tonduz*, no. 6852 herb. nat. C. R.— Turrialba, alt. 570^{m}, C. R., Nov. 1893, *Tonduz*, no. 8373 herb. nat. C. R.— Santa Clara, C. R., Sept. 1896, *Cooper*, no. 10244 herb. nat. C. R.

Sambucus oreopola Donn. Sm.— Foliola 9–11 maxima opaca supra præter nervos furfuraceos glabrescentia subtus pube cinerascente pallidiora, lateralia lanceolata sensim et acutissime elongata ad basin rotundata, terminale e medio utrinque attenuatum. Cyma decomposita 5-radiata.

Apparently arborescent. Stipules subulate, acute, $4–5^{mm}$ long. Leaves, with petiole 1^{dm} long and dilated at base added, $3–4^{dm}$ long; leaflets exstipulate, the younger elliptical-lanceolate and acuminate at each end, the fully grown ones $16–19 \times 4–5^{cm}$, the lower ones with a petiole $5–8^{mm}$ long, the upper sessile, the uppermost pair occasionally decurrent-adnate, terminal petiolule $1–2^{cm}$ long; lateral nerves about 6–8 to the side, the lower ones short, the upper long-ascending at a narrow angle with midrib, veins subobsolete on upper surface; the whole margin incurved-mucronulate-serrate. Cyme corymbiform, glabrous, $2–5^{dm}$ long, 3.5^{dm} broad; flowers 5-merous, $5–6^{mm}$ in diam. Tube of calyx semiglobose, 1^{mm} high, sulcate, little longer than the ovate lobes. Corolla within sparsely pilose. Berries not present.— A subalpine species differing little from *S. Canadensis* Linn. except by form, size and indument of leaves.

Forests of Rancho Flores, Volcán Barba, C. R., alt. 2043^{m}, Feb. 1890, *Tonduz*, no. 2107 herb. nat. C. R.— Volcán Irazú, C. R., alt. 2000^{m}, July 1891, *Tonduz*, no. 4223 herb. nat. C. R.

Burmeistera microphylla Donn. Sm.— Glabra. Folia minima internodiis longiora ovato-elliptica utrinque acuminata succulenta, margine glandulis paucis obscure crenato, nervis venisque supra impressis subtus immersis. Pedunculi nutantes foliis vix longiores. Calycis tubus parvus lobis oblongis subbrevior. Corollae tubus anguste elongatus calyce 3–plo longior lacinias supe-

riores bis superans. Columna staminea tubo triente longior, antheris inferioribus apice aureo-barbatis. Bacca globosa.

A small shrub, apparently epiphytal. Leaves 18–20 × 3–11^{mm}, yellowish beneath; nerves three to the side, reticulately anastomosing; petioles 3^{mm} long. Peduncles axillary. Tube of calyx turbinate, 1.5^{mm} high, lobes 2^{mm} long. Corolla virescent, tube 1.5^{cm} long, 2^{mm} in diameter, two superior segments 8^{mm} long, the lateral 6^{mm} long, the inferior 4^{mm} long. Staminal column adnate a little above base of tube, 2^{cm} long; superior anthers sprinkled with golden hairs, 3^{mm} long, a half longer than the others. Lobes of stigma 1^{mm} in diameter. Berry 6^{mm} in diameter, crowned with accrescent lobes of calyx.

La Palma, Costa Rica, alt. 1520^{m}, Nov. 1897, *Werckle*, no. 11600 herb. nat. C. R.

Burmeistera tenuiflora Donn. Sm.—Folia subintegra oblongo-elliptica contracto-acuminata ad basin acuta, facie inferiore pallida fusco-reticulata ad costam nervos petiolos pubescente. Calycis tubus obconicus 5-costatus in pedunculum sensim attenuatus laciniis linearibus brevior. Corollae tubus tenuis laciniis et calycinis et propriis longior. Columna staminea basi corollae adnata glabra vix exserta, antheris totis imberbibus.

Leaves 6–8×2.5–3^{cm}, petioles 6–9^{mm} long. Peduncles exceeding leaves, 5–7^{cm} long. Tube of calyx 7^{mm} long, at top 4^{mm} broad, segments 9–10×1^{mm}, their sinuate margin glandular-punctate. Tube of corolla 11^{mm} long, at top 2.5^{mm} broad; segments falcate, broad, canescent and reticulate on face, the superior ones 9×4^{mm}, the inferior a third smaller. Staminal column 2.2^{cm} long, anthers 6^{mm} long. Lobes of stigma 2^{mm} in diameter. Berries not seen.

Forests of Alto del Roble, Volcán Barba, C. R., alt. 2000^{m}, May 1888, *Pittier*, no. 19 herb. nat. C. R.

Cavendishia capitulata Donn. Sm.—Glabra. Folia subsessilia parva oblongo-obovata quintuplinervia reticulata, nervis venisque subtus immersis. Inflorescentia axillaris terminalisque sessilis, floribus paucis subcapitatis parvis e bracteis paulo emergentibus, bracteolis geminis oblongis calycem fere obtegentibus membranaceis ciliolatis. Calycis dentes acuti ciliolati. Corolla non nisi glandulis denticulata.

Apparently a small shrub. Leaves 20–25×8–9^{mm}, coriaceous, apex obtuse, base acute, margin revolute, petioles 2^{mm} long. Bracts purple, the

exterior ones minute and orbicular, the interior elliptical; the innermost largest, 12×8mm, obtuse. Pedicels 3–4, scarcely 1mm long. Bracteoles 4mm long, obtuse. Calyx 4mm high, base intruded; limb equaling tube, minutely denticulate. Corolla roseate, narrower and paler above, 12mm long, apiculated with dentiform red glands. Genitals equaling corolla. Stamens of equal length; filaments slightly cohering in a tube 2mm high, their free part alternately equaling the tube or almost none; anthers subequal, 2mm long, their tubes alternately 5 or 7mm long. Matured berry not seen.— Nearest to *C. strobilifera* Benth. et Hook.

La Palma, Costa Rica, alt. 1500m, Nov. 1897, *Wercklé*, no. 11565 herb. nat. C. R.

PERNETTYA CILIARIS D. Don, var. **alpina** Donn. Sm.— Ramuli dense setosi. Folia e basi obtusiuscula oblongo-lanceolata subtus setifera. Pedunculi folia aequantes per totam longitudinem bracteosi.

Cerro de La Muerte, C. R., alt. 3100m, Jan. 1897, *Pittier*, no. 10543 herb. nat. C. R.

Ardisia pleurobotrya Donn. Sm.— Folia obverse lanceolato-elliptica superne contracto-acuminata deorsum attenuata integra coriacea immaculata subtus lepidota. Paniculae axillares longe pedunculatae folia subaequantes lepidotae, pedicellis ad apicem ramorum primariorum alternorum umbellatim racemosis. Corollae usque ad duas partes fissae segmenta ovata acuta calycinis vix bis longiora. Antherae subsessiles breves lanceolatae longitudinaliter dehiscentes.

Younger branchlets rufescent, lepidote, internodes very short. Leaves glabrous above, beneath rufescent and densely covered with scales conspicuous under a lens, 8–10×2.5–3cm, apex obtuse; lateral nerves somewhat remote, prominent only on lower surface; petioles 6–10mm long. Panicles from upper axils, peduncles 4–7cm long, rhachis 2.5–4cm long, primary branches 1–2cm long; pedicels chiefly four or five, about 1cm long; lower bracteoles oblanceolate, 8mm long, the upper subulate and minute. Segments of calyx ovate, 2.5mm long, in center lepidote and maculate, margin hyaline and ciliolate. Tube of corolla maculate-punctate, 2mm long, segments 4mm long. Anthers inserted at middle of tube, 2.5mm long. Ovary subglobose, maculate-punctate, prolonged into style 3–4mm long, pluriovulate. Berry oval-globose, 5mm long.

Potrero del Alto, Volcán Poas, C. R. alt. 2450m, July 1888, *Pittier*, nos. 389 & 759 herb. nat. C. R.— Laguna del Volcán Barba, C. R., alt. 2753m,

Feb. 1890, *Tonduz*, no. 1949 herb. nat. C. R.— Forests of Achiote, Volcán Poas, C. R., alt. 2200^{m}, Nov. 1896, *Tonduz*, no. 10778.

Macroscepis congestiflora Donn. Sm.— Rami sicut petioli costae inflorescentia pilis longis patentibus fusci. Folia longiuscule petiolata obovata cuspidato-acuminata basi bilobata, nascentia villosa, adulta pilis brevibus appressis utrinque aspersa subtus pallida. Flores ebracteolati numerosissimi in umbellam globosam petiolum aequantem conferti, pedicellis pedunculum subaequantibus. Corollae calyce triente longioris tubus globosus glaber pallidus, limbus nigrescens intus papillosus tubo vix longior ultra medium suborbiculari-lobatus. Coronae squamae inclusae apice inflexo truncatae. Gynostegium brevissimum, caudiculis subnullis, disco stylino concavo.

Leaves 12–21×8–12^{cm}, margin pilose, basal lobes chiefly incumbent, nerves 7–9 to the side, petioles 3–4^{cm} long. Pedicels 25–40, 8–15^{mm} long; bracteoles linear-lanceolate, subequaling pedicels. Segments of calyx pilose, oblong-ovate, 10×5^{mm}. Tube of corolla 6^{mm} long; spreading limb pubescent beneath, nearly 2^{cm} in diam. Coronal scales subquadrate. Anthers tipped with an oval membrane 1^{mm} long. Gynostegium 2^{mm} high. Disk of style 2^{mm} in diam. Follicles not present.— A species with the foliage of *M. obovata* HBK. and the dense umbels of *M. Trianæ* Decne., but differing from both by the structure of the bractless flowers.

River-banks, La Sierra near Mataguescuintla, Depart. Santa Rosa, Guatemala, alt. 1500^{m}, *Heyde & Lux*, no. 6350 Pl. Guat. etc., qu. ed. Donn. Sm.

PROSTHECIDISCUS Donn. Sm., nov. gen. *Asclepiadearum.*— Sepala basi intus pauciglandulosa. Corolla alte partita reflexa, segmentis linearibus in praefloratione rectis et dextrorsum obtegentibus. Corona exterior infra apicem antheriferum columnae stamineae elongatae annularis 5-crenata, interior ad carinas 5 dorso filamentorum adnatas reducta. Antherae membrana inflexa terminatae, polliniis in quoque loculo solitariis compressis pendulis, caudiculis hyalinis brevibus. Discus stylinus in rostrum parum angustius cylindraceum superne complanatum productus. Folliculi lanceolato-ovoidei tuberculato-echinati.— Suffrutex volubilis. Folia opposita cordiformia. Racemi ex una axilla pedunculati.

Genus inter Cynancheas locandum ad Oxypetalum quodammodo accedit.

Prosthecidiscus Guatemalensis Donn. Sm.— Simul setulosus et glanduloso-pubescens. Folia longipetiolata suborbicularia cuspidato-acuminata lobis rotundatis et imbricatis cordata supra pilis brevibus parce onusta subtus praeter nervationem fuscam glandulosam et setulosam glabra et pallida, margine repando. Pedunculi petiolis sublongiores racemum superantes, pedicellis bibracteolatis flores aequantibus. Sepala lanceolata intus 3–5 glandulosa. Corolla extus pilis brevibus sparsissime obtecta intus glabra in praefloratione basi intrusa sepalis 4-plo tubo decies longior. Corona minuta, crenis tumidis. Ovaria stylos aequantia. Disci appendicium gynostegio 3-plo breviore adjecto corollam aequans.

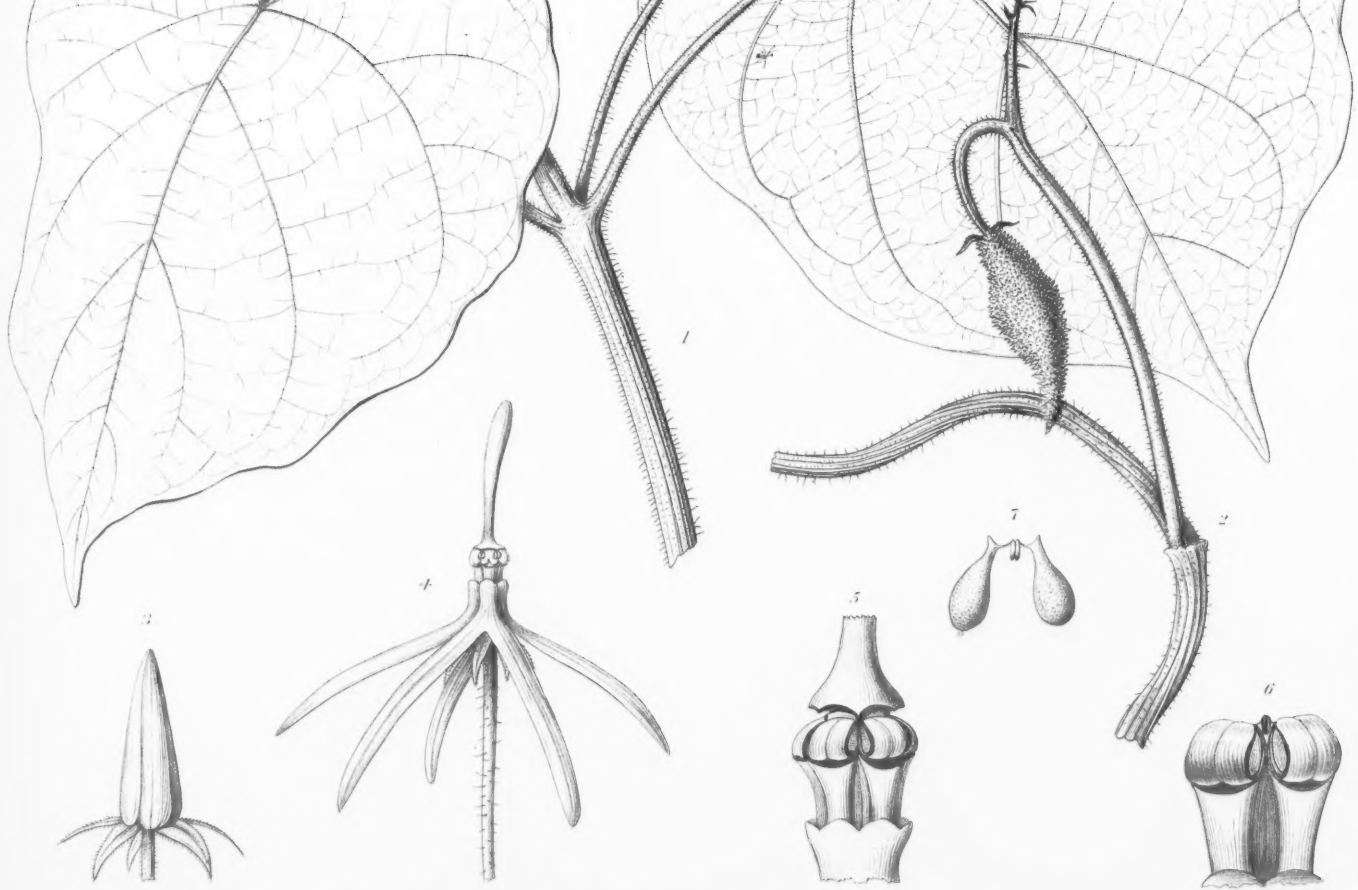
Leaves 9–13×8–12^{cm}, petioles 4–6^{cm} long. Racemes 6–12-flowered; bractlets filiform, 3–4^{mm} long. Flowers turning black in drying, 2^{cm} long. Anthers 1^{mm} long. Pistils 4^{mm} long. Matured follicles not present.

Cerro Gordo, 2½ leagues N. W. from Cenaguilla, Depart. Santa Rosa, Guatemala, alt. 1100^{m}, Sept. 1892, *Heyde & Lux*, no. 3845 Pl. Guat. etc., qu. ed. Donn. Sm.

EXPLANATION OF PLATE XII.— Fig. 1, stem with leaves and flowers. Fig. 2, same with young follicle. Fig. 3, bud. Fig. 4, flower. Fig. 5, gynostegium with corona and base of stylar disk. Fig. 6, stamens. Fig. 7, pollinia.

Bourreria litoralis Donn. Sm.— Folia longe petiolata ex oblongo-ovato elliptica et utrinque acuta aut obtusa supra pilis e tuberculo ortis plus minus scabriuscula subtus pubescentia. Cyma laxiramosa, axibus filiformibus patulis. Calyx parvus dentibus acute triangularibus usque ad medium fere partitus corollae tubum aequans lobis dimidio brevior. Filamenta ad basin dilatatam villosa duabus partibus exserta.

A small tree. Branchlets and inflorescence glabrescent. Leaves variable in outline, sometimes oval and 7.5×5^{cm}, sometimes ovate- or obovate-elliptical and 12×6^{cm}, petioles 1.5–3.5^{cm} long. Cyme corymbose, chiefly exceeding leaves; bracteoles lanceolate, minute, caducous. Calyx 4^{mm} high, externally pilose, internally except canescent teeth glabrous. Lobes of corolla suborbicular, 8–9^{mm} long. Filaments inserted at apex of tube, 4^{mm} long, twice exceeding oblong anthers. Ovary, with style at apex bifid added, twice longer than calyx, stigmas capitate. Drupe not present.— By structure of flowers nearest to *B. formosa* Hemsl.



C.E. Faxon, del.

PROSTHECIDISCUS GUATEMALENSIS, Donn. Sm.

B. Meisel, Lith. Boston.

Forests on the plain of Salinas, Golfo Dulce, Costa Rica, July 1890, *Pittier*, nos. 2787 and 2814 herb. nat. C. R.

TOURNEFORTIA NELSONI, proposed as a new species in BOT. GAZ. **23**: 10. 1897, and founded upon no. 3615 of Nelson's collections in Guatemala, does not appear to differ from *T. petiolaris* DC.

Tournefortia subspicata Donn. Sm.—Praeter inflorescentiam corollamque subglabra. Folia longe petiolata obovato-elliptica utrinque acuminata discoloria supra minutissime lepidota, nervi laterales crebri cum venis subparallele transversis subtus conspicui. Cyma pluries dichotoma, floribus dissitis subsessilibus. Corollae tubus calyce vix bis longior, lobi ovato-lanceolati tubi dimidium fere aequantes. Pistillum calycem vix aequans.

Fruticose. Branchlets sulcate. Leaves 10–12×4–6^{cm}, the upper often opposite or ternate, in drying rugose above and flavescent beneath; lateral nerves 8–10 to the side, like the veins nigrescent beneath and sparsely pubescent; petioles 2–3.5^{cm} long. Peduncles terminal, erect, dichotomous, spikes recurved and like the corolla flavescent with a strigillose pubescence, pedicels chiefly 1–2^{mm} long. Segments of calyx glabrous, becoming black in drying, ovate-lanceolate, 4^{mm} long. Tube of corolla 7^{mm} long, ampliate at throat, lobes 3^{mm} long and acute. Stamens subsessile at middle of tube; anthers linear, 2.5^{mm} long, muticous. Ovary glabrous, conic–ovoid, short style stigmatose below the conic apex. Drupes not seen.

Plateau of Volcán Turrialba, Costa Rica, alt. 2700^{m}, Jan. 1891, *Pittier*, no. 877 herb. nat. C. R.

Calceolaria sciadephora Donn. Sm. (§ CHEILONCOS Wettst. in Engl. et Prantl. Natuerl. Pflanzenfam. **4**^{3b}: 55. § *Perfoliatae* Benth.) — Viscoso-pubescens. Folia subtus incano-tomentulosa grosse duplicato-dentata elongato-deltoidea in petiolos dimidio breviores late alatos basi dilatata dentata connatos abrupte contracta. Pedunculi elongati apice bracteato subumbellatim multiflori, pedicellis filiformibus. Calyx luteus corolla triente brevior labio postico bis longior. Antherae reniformes, loculis confluentibus proclinatis.

Suffruticose, erect, tall. Leaves discolorate, with petiole 5–7^{mm} broad added 8^{cm} long, 3.5^{cm} broad, acute, base truncate, interpetiolar wing 9–12^{mm} broad. Peduncles from upper axils, 4.5–7^{cm} long; pedicels 2–3^{cm} long,

chiefly umbellately, occasionally corymbosely, 9–14-fasciculate; bracts foliaceous, sessile, ovate-lanceolate, 2.5–3^{cm} long. Calyx colored like corolla, pubescent on both sides, segments ovate, 8–9^{mm} long. Corolla glabrous, 12–14^{mm} long; posterior lip truncate; 4–5^{mm} long; anterior lip oblong-obovate; aperture 7×4^{mm}. Cells of anthers oval, 2^{mm} long, continuing pendulous after anthesis. Ovary pubescent, with glabrous style added 8^{mm} long. Capsules not present in the specimens.— This alpine species is to be located between *C. tomentosa* Ruiz et Pav. and *C. calycina* Benth., resembling the former by leaves and flowers, and the latter by inflorescence, but differing from both by anthers.

Páramos de La Muerte at the limits of the forest growth, Costa Rica, alt. 3100^{m}, Jan. 1891 and 1897, *Pittier*, nos. 3486 and 10542 herb. nat. C. R.

Solenophora calycosa Donn. Sm.— Fusco-pubescens, nodis glabris. Folia ovata aut ovato-elliptica acuta basi inaequalia et obtusa punctata supra pubescentia subtus praeter nervos glabra duplicatim denticulata. Pedunculi petiolos subaequantes quam flos dimidio breviores medio bibracteolati uniflori. Calyx e basi turbinata tubuloso-campanulatus, lobis brevibus rotundis denticulatis. Corolla coccinea calycem 3-plo paene superans, lobis integris intus flavis et immaculatis.

Leaves unequal in the pairs, the greater 13–22×8–12^{cm}, the other a third smaller, lateral nerves 7–9 to the side, petioles 4–7^{cm} long. Peduncles about 5^{cm} long, bracteoles minute. Calyx reticulately veined, at base and within more densely pubescent, 3.3^{cm} long, adnate part 7^{mm} long, lobes 5^{mm} long and broad, teeth apiculated with a red gland. Corolla pubescent without, glabrous within, 8.5^{cm} long, limb oblique, lobes 1^{cm} long and 1.5^{cm} broad. Stamens included; filaments free, inserted at very base of tube; anthers 3^{mm} long, cohering quadrately, cells diverging at base. Gland of disk broad, bilobed, pubescent. Style pubescent, 5.5^{cm} long; stigma entire, stomatomorphous. Fruit unknown.

Slopes of Volcán Barba, Costa Rica, alt. 2300^{m}, July 1888, *Pittier*, no. 283 herb. nat. C. R.— Borders of Río Mancaron, Volcán Barba, Atlantic side, alt. 2100^{m}, Feb. 1890, *Tonduz*, no. 2022 herb. nat. C. R.

Episcia longipetiolata Donn. Sm. (§ CENTROSELENIA Benth. in Hook. Lond. Journ. Bot. **5**: 362.)— Praeter inflorescentiam puberulam glabra. Folia magna petiolis tenuibus vix ac ne vix longiora ovata obtusa denticulata membranacea nitida. Flores umbellatim congesti, pedunculis bracteosis et pedicellis brevibus. Segmenta calycina sicut bracteae linearia filiformi-attenuata, pos-

tico sejuncto paulum breviore. Corolla calyce bis longior saccata anguste tubulosa, lobis maculatis fimbriatis. Glandula sola integra.

Leaves 22–25 × 12–16^{cm}, shortly cuspidate, slightly cuneate at base; nerves 14–15 to the side, like midrib fuscous beneath. Peduncles aggregated in the axils, 2–3^{mm} long; bracts several, 18–25^{mm} long, the exterior ones broader and shorter; pedicels 4–6, about 6^{mm} long. Segments of calyx 1.5^{cm} long, like bracts puberulous and entire. Corolla glabrous, straight, cylindrical, 3^{mm} broad, abruptly ampliate into limb, lobes equaling width of tube. Anthers ovate, 1^{mm} long, naked. Gland 1^{mm} high, black. Ovary pilose, style a little shorter than corolla. Fruit not present.— To be located with *E. congesta* Hanst. and *E. glabra* Hanst., but differing remarkably from both by the petioles.

Borders of the road to Carrillo, Costa Rica, alt. 300^{m}, June 1890, *Tonduz*, no. 2493 herb. nat. C. R.

Alloplectus stenophyllus Donn. Sm.—Omnibus in partibus glaberrimus. Folia uniuscujusque paris dimorpha, alterum petiolatum oblongo-aut lineari-lanceolatum, alterum subsessile acuminato-ovatum 3–4-ies minus. Pedunculi ex axillis foliorum majorum orti bini calyce breviores basi minute bracteolati. Calyx herbaceus, segmentis oblongo-lanceolatis, postico paene sejuncto, ceteris bis majoribus altius connatis corollae basi saccatae dimidium aequantibus. Antherae oblongae, loculis linearibus infra medium divergentibus.

Epiphytal. Larger leaf in the pairs 11–26 × 3–4^{cm}, very acute, petiole 1.5–2.5^{cm} long; the smaller leaf 4–6 × 2–2.5^{cm}. Peduncles 5–8^{mm} long, 1-flowered; bracteoles linear-lanceolate, 3–4^{mm} long. Calyx oblique; segments subentire, nerved, 13–17^{mm} long. Corolla pale-roseate; tube straight, 3^{cm} long, 1^{cm} broad at top; lobes rotund, subequal, 5^{mm} long. Stamens inserted a little above base of tube; filaments twisted after anthesis; anthers cohering, 5^{mm} long, affixed at middle, tumid at apex, sagittate below insertion. Gland posterior, single. Ovary 4^{mm} long, style 1.5^{cm} long, stigma stomatomorpho-bilobate. Fruit enclosed in the scarcely accrescent calyx oblong-ovoid, 1.5^{cm} long.

Forests of Suerre, Llanuras de Santa Clara, C. R., alt. 300^{m}, Apr. 1896, *Donn. Sm.*, no. 6724 Pl. Guat., etc., qu. ed. Donn. Sm.— Rio Verde, Llanuras de S. Clara, C. R., alt. 200^{m}, May 1896, *Donn. Sm.*, no. 6726 Pl. Guat. etc., qu. ed. Donn. Sm.— Forests of Tuis, C. R., alt. 650^{m}, Nov. 1897, *Tonduz*, no 11512 herb. nat. C. R.

Alloplectus ventricosus Donn. Sm. (§ HYPOCYRTOIDEI Hanst. in Linnaea **34** : 377.)—Folia cum caule glabra ampla oblongo-lanceolata utrinque acuminata integra subtus rubescentia disparia, cujusque paris majus rarius utrumque longe petiolatum. Pedunculi toti bracteosi apice congestiflori. Calycis segmenta sicut bracteae paulo majores pubescentia sanguinea ovalia. Corolla tomentosa calyce pallidior et bis fere longior superne inflato-ventricosa et ore bis amplior, lobis minutis erectis. Antherae oblongae bilobae.

Epiphytal; stem stout. Leaves shining, the larger in the pairs 28 x 9^{cm} and attenuated into a petiole 5^{cm} long, a third or a half longer than the other one; nerves 6–7 to the side, arcuately ascending to the margin, like midrib stout beneath. Peduncles stout, 1.5–2^{cm} long; bracts imbricating, not involucrate, orbicular-oval, 1.5^{cm} long, contracted into a short stipe; pedicels short recurved. Calyx oblique; segments obovate-oval, 12^{mm} long, apex denticulate, the posterior one a half smaller. Corolla declinate at base, above the middle obovate-ventricose, 2^{cm} long, 1^{cm} broad at top, lobes 2^{mm} long. Anthers 3^{mm} long. Gland posterior, solitary. Fruit puberulous, spherical, 12^{mm} in diam., exceeded by the accrescent calyx, dehiscing in 2 valves.—Related to *A. sparsiflorus* Mart.

Atirro, Prov. Cartago, C. R., alt. 600^{m}., April 1896, *Donn. Sm.* no. 6727 Pl. Guat., etc., qu. ed. Donn. Sm.

Codonanthe macradenia Donn. Sm.—Praeter petiolos pedunculos flores puberulos glabra. Folia carnosa opaca elliptica utrinque acuta, costa in utraque facie immersa, nervis obsoletis. Pedunculi solitarii aut gemini petiolo bis longiores. Calyx pedunculum subaequans, segmentis filiformi-linearibus corolla recta leviter ventricosa dimidio brevioribus. Stamina inclusa. Disci glandula majuscula.

Epiphytal; stems sparingly branched, rooting at nodes, the younger rubro-maculate and puberulous. Leaves becoming pallid in drying, 3–5 × 1.5–2.5^{cm}. Calyx oblique; segments fusco-puberulous on both sides, equal, 9^{mm} long. Corolla yellow, tube above gibbous base ampliate, cylindrical, 2^{cm} long, at throat 6^{mm} broad; lobes veiny, orbicular, 2^{mm} in diameter. Filaments free, inserted at base of tube; anthers connivent by pairs; cells globose, separated. Gland of disk stout, 2^{mm} high, apex retuse. Ovary puberulous, conic-ovoid, hardly 3^{mm} high; style villose, a half shorter than corolla. Berry oval-spherical, apiculate, 1^{cm} long, a little exceeding the augmented calyx, indehiscent.—Nearest to *C. gracilis* Hanst.

Borders of the river at Boruca, Costa Rica, alt. 460^{m}, Mch. 1892, *Tonduz*, no. 6769 herb. nat. C. R.— Forests of Santo Domingo de Golfo Dulce, C. R. Mch. 1896, *Tonduz*, no. 10051 herb. nat. C. R.— Hacienda de La Concepcion, Llanuras de Santa Clara, C. R. alt. 250^{m}, Apr. 1896, *Donn, Sm.*, no. 6719 Pl. Guat. etc., qu. ed. Donn. Sm.

Besleria imbricans Donn. Sm. (§ PODOBESLERIA Benth. et Hook.)— Folia longipetiolata magna oblongo-elliptica utrinque deorsum longius acuminata discoloria supra vix puberula subtus minute canescentia integra, nervis lateralibus utrinsecus circiter 16. Pedunculi elongati ad apicem racemuloso-pauciflori, floribus glabris. Calyx amplus glandulis rubris minute punctatus usque ad basin fere partitus in praefloratione clausus, segmentis orbiculari-ovalibus concavis valde imbricatis, postico minore et magis orbiculari, ceteris basi obliquis. Corolla coccinea quam calyx dimidio longior obovoidea breviter calcarata. Antherae globosae. Annulus inaequalis.

Herbaceous. Leaves 20–29 × 9–11^{cm}, pale beneath; nerves spreading, reaching nearly to margin; petioles 3–5^{cm} long. Peduncles 1^{dm} long; pedicels about 4, subequaling calyx. Segments of calyx 9–12^{mm} long. Corolla 2^{cm} long, mouth contracted; lobes rounded, 2^{mm} long. Stamens inserted near base of tube; filaments flat, 7–8^{mm} long; anthers 2.5^{mm} in diam., conniving by their apexes in a square; cells arcuate, confluent. Posterior half of annulus stout, oblique; the anterior half rudimentary. Ovary obovoid-globose, 3.5^{mm} long, glabrous; style stout, 8^{mm} long, glabrous, stigma conspicuously bilobed. Drupe not present.

Forests of Shirores, Talamanca, Costa Rica, alt. 100^{m}, Feb. 1895, *Tonduz*, no. 9192 herb. nat. C. R.

Besleria macropoda Donn. Sm. (§ PSEUDOBESLERIA Oerst.)— Tota praeter apicem ramulorum cum foliis nascentibus pubescentem glabra. Folia breviter petiolata oblongo-lanceolata aut -elliptica tenuiter acuminata basi angustata aut obtusiuscula calloso-denticulata crebre penninervia. Pedunculi longissimi, pedicellis gracilibus umbellatis pluribus. Segmenta calycina sejuncta aequalia lineari-lanceolata subulato-acuminata 3-nervia. Corolla aurantiacea e basi aequali urceolata calycem vix superans. Antherae reniformes. Annulus integer.

Apparently a tall herb. Leaves 10–14 × 3–5^{cm}, paler beneath; lateral nerves approximate, about 11 to the side, ascending nearly to margin, fus-

cous beneath; petioles canaliculate, 5–7^{mm} long. Peduncles 6–13^{cm} long; pedicels about 5–9, chiefly 2^{cm} long. Segments of calyx, with the 3^{mm} long mucro added, 10–12^{mm} long. Corolla 12–13^{mm} long; lobes 2^{mm} long, the superior two broader and connate. Stamens inserted below middle of tube, anthers conniving by their apexes in a square. Ovary conic-ovoid, equaling style. Fruit globose, 6^{mm} in diam., included in the not augmented calyx, apiculated by the remains of style, pericarp granulated.—Related to *B. laxiflora* Benth.

Damp woods at El Recreo, Costa Rica, July 1888, *Pittier*, no. 572 herb. nat. C. R.—Borders of road to Carrillo, C. R., alt. 300^{m}, May 1890, *Pittier*, no. 2495 herb. nat. C. R.—Forests of Tuis, Prov. Cartago, C. R., alt. 650^{m}, Oct. 1897, *Tonduz*, no. 11358 herb. nat. C. R.

Besleria robusta Donn. Sm. (§ PSEUDOBESLERIA Fritsch in Engl. et Prantl. Natuerl. Pflanzenfam. 4^{3b} : 158; non Oerst.)—Caulis petiolique crassi tomentosi. Folia coriacea integra maxima obovata acuta deorsum attenuata penninervia evenia supra glabra. Flores paucifasciculati breviter pedunculati. Calyx alte partitus extus sericeus intus glaber et rubescens, segmentis aequalibus oblongo-ovatis. Corolla glabra e basi vix gibbosa tubulosa calycem paulo superans, limbo aequali patulo.

Stem terete, near apex 1^{cm} in diam., internodes 1^{dm} long. Leaves 30 × 14^{cm}, becoming pale in drying, with scattered hairs beneath; nerves 12 to the side, extending to margin, like midrib tomentose beneath; petioles 5.5^{cm} long, 5–6^{mm} thick, canaliculate. Peduncles sericeous, 6–8^{mm} long. Segments of calyx 12^{mm} long. Corolla apparently yellow, succulent, puberulous within, 14^{mm} long, 3^{mm} wide, suberect; lobes round, 3^{mm} long. Stamens inserted below middle of tube, the rudimentary one 4^{mm} long; anthers reniform, cohering; cells oblong, 2^{mm} long, connective triangular. Annulus equal. Ovary glabrous, oblong-conical, with equal style added as long as calyx, stigma distinctly bilobed. Fruit not seen.—Nearest to *B. Riedeliana* Hanst.

Forests of Tsâki, Talamanca, Costa Rica, alt. 200^{m}, Apr. 1895, *Tonduz*, no. 9556 herb. nat. C. R.

Tabebuia sessilifolia Donn. Sm.—Glabra. Folia oblanceolata cuspidato-acuminata in basin sessilem sensim attenuata. Pedunculi ad apicem bracteosum ramulorum pauci-aggregati. Calyx coriaceus amplus pedunculum aequans spathaceo-fissus demum bilobus, tubo campanulato, lobis oblongo-ovatis integris enerviis. Corolla infundibuliformis intus praesertim ad lobos tuberculoso-

puberula. Discus pulvinatus. Ovarium conicum lepidotum, ovulis in utroque loculo 4-serialibus.

Leaves simple, crowded toward the end of branchlets, membranaceous, minutely lepidote, 13–17 × 4.5–5^{cm}, midrib stout beneath; lateral nerves spreading at nearly a right angle, 14–18 to the side, conspicuous beneath. Peduncles stout; bracts linear, 1.5^{cm} long. Calyx smooth and shining, becoming black in drying, 3.2^{cm} long. Corolla (imperfectly developed in the specimens) scarcely twice longer than calyx, eternally glabrescent, tube at base 5^{mm} broad. Stamens inserted a little below middle of tube, subexsert; cells of anthers elliptical, 4^{mm} long, divaricate. Disk 3^{mm} high, 5^{mm} broad. Ovary 5^{mm} long, lips of stigma obtuse. Capsule not present.—Approaching *T. obtusifolia* Bur. by its equally large calyx, but differing by sessile and acuminate leaves and by inflorescence.

Forests of Tablazo, Costa Rica, alt. 1800^{m}, Apr. 1893, *Tonduz*, no. 7937 herb. nat. C. R.

Aegiphila odontophylla Donn. Sm. (§ CYMOSAE Schau.)—Pubes pallide ochracea, in ramulis inflorescentiaque tomentulosa, in calyce foliorumque nervis subfurfuracea. Ramuli obtuse quadrangulati verrucosi. Folia praeter nervos glabrescentia oblongo-obovata acute acuminata in petiolum attenuata, ambitu toto fere serrato. Pedunculi petiolos subaequantes cymis pluries dichotomis laxifloris paulo breviores. Calyx obconicus venosus, lobis semiorbicularibus nervo excurrente apiculatis. Corolla glabra, lobis ovalibus.

Leaves opposite, 1–1.4^{dm} × 3.5–5.5^{cm}; lateral nerves 8–10 to the side, like veins pubescent and conspicuous beneath; margin, except at base, conspicuously serrate, teeth antrorse and mucronate-apiculate; petioles 1–1.5^{cm} long. Cymes axillary, bracteoles subulate, flowers 4-merous. Calyx 5–6^{mm} high, externally furnished with a few large glands, lobes 1.5^{mm} long. Corolla hypocraterimorphous, 1.2^{cm} long; lobes obtuse, 5^{mm} long. Drupes not present.

Forests on southern slope of Vulcán Barba, Costa Rica, alt. 2100^{m}, July 1888, *Pittier*, no. 288 herb. nat. C. R.

BALTIMORE.

CENTROSOMES IN PLANTS.

L. GUIGNARD.

THERE are few questions in cytology to which so much attention has been paid in recent years, especially by zoologists, as that of centrosomes and directive spheres. First observed, as is known, in animal cells undergoing division, they were later also found in the same cells in a resting stage. The presence of centrosomes in plants had not been demonstrated before my investigation of the subject. But, according to recent work, instead of being of general occurrence in plants, as was believed, they may be limited to the lower groups of the plant kingdom. However, in a subject so difficult, in which the record of new observations may be expected daily in consequence of the incessant progress of investigation, I do not believe absolute assertion of such an opinion is prudent.

Without entering into details, it will suffice to recall first that in animal cells the morphological and microchemical characteristics of the attractive spheres and centrosomes may be far from uniform. It is at least agreed that the centrosome is to be considered the important part of the sphere. Usually it is a refractive corpuscle, sometimes of extreme smallness. The sphere itself is formed of a substance which can be differentiated into two zones; one clear toward the center, the other granular toward the periphery. Also, it is often poorly defined, and of a refrangibility different from that of the surrounding protoplasm. The radial striation which usually surrounds it has its origin partly in the centrosomes, partly in the central region of the sphere.

In animal cells in the resting stage the sphere is often lacking, or is indicated only by a slight protoplasmic condensation around the centrosome. Sometimes it is even disorganized and

then reorganized before the division of the nucleus. It is formed of that substance which certain authors have called archoplasm, or kinoplasm, in order to distinguish it from the nutritive protoplasm or trophoplasm. It can be said in a general way, therefore, that the centrosome is the fundamental element of the sphere, since often it alone persists, and it is the centrosome which has the greatest affinity for staining fluids. However, it is known that in certain cases, observed especially by Van der Strich and von Rath, the attractive sphere conceals the centrosome, but one is not justified perhaps in concluding that the latter element is in such a case completely absent.

Some observers have asserted, also, that the centrosomes and the spheres have no distinct existence, but are appearances resulting from certain activities of the protoplasm.

It does not seem possible at present to characterize the centrosomes by their composition, or by the manner in which they behave in respect to stains. Yet Heidenhain, and other authors claim that the centrosomes are composed of a particular chemical substance; while Viessing thinks that to find the specific character of these bodies it is necessary to study, not their chemical composition, but their position in the center of a protoplasmic radiation which they serve as a point of attachment.

In the resting animal cell there has been observed a single centrosome, sometimes two neighboring centrosomes, sometimes even numerous centrosomes lying side by side and forming the "microcentre" of Heidenhain, or the "centriole" of Boveri. In this last case the typical centrosome is replaced by a group of granules, which divides, like a typical centrosome, into two at the beginning of nuclear division.

Often the centrosomes, very small and scarcely visible at the moment of nuclear division, increase in size during that process, divide at the same time as the nucleus, and then return to their former condition and cease to be recognizable. There are several authors, however, who do not consider the centrosomes permanent organs of the cell, but such is not the opinion of the majority of zoologists, who have observed centrosomes

in cells of very diverse nature and in the period of complete rest. Their appearance in animals seems general and in all phases of the life of the cell.

It may prove, however, not to be the same with plants. The observations of Farmer, of Strasburger and his pupils, tend to show that among plants these elements occur only in the thallophytes and lower bryophytes; and that they may not exist at all in vascular cryptogams and phanerogams. Such a difference between thallophytes and cormophytes on the one hand, and between the latter and animals on the other, is somewhat surprising when one considers the analogies presented in the fundamental structure of the cell, especially in the phenomena of nuclear division, in the great majority of plants and animals. However, the question may depend wholly upon the difference between purely theoretical views.

Among lower plants in which centrosomes have been described by the preceding observers, they present morphological variations analogous to those with which we are familiar in animals. For example, in Fucus, in the developing oogonia and the segmenting eggs, Strasburger has observed centrosomes surrounded by well differentiated radial striations. Swingle has made similar observations in the vegetative cells of Sphacelaria, with this difference, that instead of having the form of a rounded granule, the centrosome resembles a little box (boitonnet), a dumb-bell, or is club-shaped. This centrosome divides, persists during the resting period, and varies but slightly in size. Among these plants the centrosome seems to be without any clearly differentiated surrounding sphere, but the sphere has been observed by Farmer and Strasburger in some of the Musci.

Among fungi (Peziza, Ascobolus, Erysiphe) Harper has found, instead of an ordinary centrosome, a granular body of discoid form from which extend radial striations. According to Fairchild Basidiobolus has barrel-shaped spindles; that is, truncated at their polar extremities, and composed of several strands of threads, each strand being terminated by a distinct granuel which stains readily. Similar strands have been observed in

animals (Ascaris, Cyclops, etc.), but here it was a form merely transitory which precedes the normal bipolar stage which, when attained, shows centrosomes of the usual type.

These observations all go to prove that our conception of centrosomes should be much broader and more general than at the beginning of our acquaintance with them.

One of the principal arguments against the existence of centrosomes among the cormophytes is drawn from the method of formation of the nuclear spindle. Many observers have stated that the spindle, instead of being bipolar from the first, begins with a variable number of poles; often more than a dozen, according to Osterhout, in the spore-mother cells of Equisetum; a half dozen or less, according to Mottier, in the pollen mother cells of Lilium, Podophyllum, etc. But at a fixed time these multipolar spindles always become bipolar, either by fusion, or by the drawing in of the filaments which form the multiple cones of the primitive figure. Neither at the summit of these multiple cones, nor at the extremities of the bipolar spindle derived from them, have these authors seen anything showing the character of a centrosome. It may be asked, then, what are the forces which thus change the multipolar to the bipolar spindles. If, according to the preceding observers, neither centrosomes nor anything capable of their function is present, one must invoke a mechanical explanation for these changes. Can it be the chromosomes which orient the achromatic threads of the spindle? Well-known facts tend to show precisely the contrary. If one believes in the absence of any kinetic center, it only remains to admit with Strasburger that the forces in play reside in the kinoplasm, independent of any special morphological differentiation. The opinion of a distinguished scientist may perhaps be given some weight.

Even though all earlier observations upon the presence of attractive spheres and centrosomes in different cormophytes may be regarded as inexact, one cannot doubt that the bodies recently described and figured by Webber in the pollen cells of Zamia, although they serve at a given moment in the formation

of the cilia of the antherozoids of this cycad, are centrosomes; and the same thing appears likely to be the case in Gingko, studied earlier by Hirase.

The following are the results of my recent investigations of the pollen mother cells of various phanerogams (*Nymphæa alba*, *Nuphar luteum*, *Limodorum abortivum*), examined after fixation in Flemming's fluid and other suitable reagents.

In Nymphæa, which is of particular interest, the adult mother cell contains an excentric nucleus, lying very near the wall, the rest of the cell being almost entirely filled with starch. At the commencement of the prophases of division the cytoplasm assumes a filamentous appearance around the nucleus, in which the chromosomes (apparently thirty-two in number) are peripherally placed in contact with the nuclear membrane, and in addition to the nucleolus a certain number of very fine achromatic threads can be distinguished.

In the neighborhood of the nucleus certain stains, such as a mixture of methyl-green, fuchsin, and orange G, bring out one or two small differentiated bodies, sometimes of homogeneous aspect, sometimes provided with a more deeply stained central granule and sometimes more numerous. At certain stages they act as points of attachment for cytoplasmic threads directed towards the nucleus, and form the first outline of the nuclear spindle. Sometimes tripolar or even quadripolar spindles are found, but the final figure never has more than two poles, occupied by a small sphere which has for its center either a single granule or several granules in a group, whose deep green color, brought out by the stain indicated, is like that of the chromosomes. These elements can also be stained by other methods. On account of the small number of multipolar spindles that I have observed, I am not able to suggest, at present, in what manner the multipolar spindles become bipolar.

The nuclear spindle forms on the side of the cell, becoming curved in accordance with its contour. The two cones which compose it, and whose bases correspond to the nuclear plate, elongate and incurve more and more, until the spindle becomes

crescent-shaped, and sometimes twisted upon itself in the form of an S. The length of the crescent often equals half the circumference of the cell. This singular elongation appears to depend upon polar bodies which always occur at the points of the spindle. During the process sometimes these bodies are represented by a sphere with one or more granules, and sometimes the sphere does not appear stained as the rest, a difference which may be attributed, in part, to the variable action of the reagents. In every case these bodies certainly represent centrosomes. Striations are also often to be seen extending from them into the cytoplasm.

Often, also, the ends of the spindle are extended into a slender point, formed by several granules disposed in a line. One might think that in this case there is no centrosome at the pole, but, in my judgment, it is to be explained by the dissociation of the primitive centrosomes, whose numerous granules have disposed themselves in this way. The reaction of these elements to stain certainly suggests this view.

The centrosomes are found in all the phases of nuclear division. After the formation of the daughter nuclei they can still sometimes be seen, becoming indistinct but not actually disappearing. They are found during the second division of the mother cell.

In Nuphar the nucleus is not lateral, but occupies a central position in the cell, which is completely filled with starch grains. The cytoplasm presents an alveolar appearance. The character of the nuclear division differs from that in Nymphæa in being of the normal type. It is to be remarked that the chromosomes are twelve in number, their arrangement in the nuclear plate stage being in groups of four, observed by Calkins in the ferns, and by many zoologists in the copepods and other animals. At the beginning of the prophases multipolar spindles are also found, at whose extremities there is very often a granule or a more or less distinct sphere serving as the point of departure for achromatic threads. At later stages the polar bodies or centrosomes resemble those of Nymphæa, but the bipolar spin-

dle, formed at the center of the cell, always lies as in ordinary cases.

It is exceedingly difficult to detect the bodies representing centrosomes in Limodorum. Multipolar spindles are very frequent, and in general their branches are very numerous and very variable in appearance. At the extremity of many of them, however, there is seen a granule, or a small mass of substance more stained than the rest of the cytoplasm. During the formation of the bipolar spindle, those granules nearest the points subsequently occupied by the two final poles, points determined by the form of the cell, seem to persist, the others disappearing. It can be supposed that several isolated bodies sometimes unite to form a single centrosome, for, after the formation of the bipolar spindle, bodies are often seen at each pole. A distinct sphere was not observed, but time after time very delicate radiations from each pole were seen.

To summarize, I may say that it does not appear permissible to advance the formation of multipolar spindles, which may be accidental or normal, as an argument against the existence of dynamic centers during nuclear division. It remains a fact that at a certain time there appear in the cytoplasm bodies distinct from the ordinary granules. It is possible that the construction of the multipolar figures may be independent of the elements which form centrosomes. It may also be true that centrosomes are not always definite morphological units. But it is none the less certain that the higher plants possess differentiated elements whose rôle is the same as that of those analogous bodies observed in the lower plants and in animals.

PARIS.

NEW SPECIES AND EXTENDED RANGES OF NORTH AMERICAN CARYOPHYLLACEÆ.

B. L. Robinson.

(WITH PLATE XIII)

Since the publication of the last fascicle of the *Synoptical Flora*, containing a revision of the North American Caryophyllaceæ, four additional species, belonging to this family and growing within the range of the work mentioned, have come to the notice of the writer. These plants have been recently discovered in widely separated parts of our continent, and, with the possible exception of the Drymaria mentioned below, are undoubtedly indigenous, so that together they form a noteworthy addition to our already rich representation of this attractive family.

Stellaria oxyphylla.— Decumbent and rooting from the lower nodes: stems striate, leafy, dichotomously branched above, 3^{dm} or more in length, glabrous except along a puberulent line upon the dorsal surface of each branch: leaves elongated, lanceolate, caudate-attenuate, becoming 1^{dm} or more in length, 8 to 13^{mm} in breadth, nearly concolorous, minutely warty upon both surfaces, sparingly or even obsoletely ciliolate upon the margin, gradually attenuate to sessile somewhat connate bases; midrib pale, prominent upon the lower surface; veins finely reticulated (an intramarginal one clearly visible by transmitted light): peduncles slender, spreading or at length deflexed, 25 to 35^{mm} long, often nodding or recurved at the summit, borne in the forks of the branches and in the axils of the highest leaves: calyx glabrous, subturbinate at the base; sepals lanceolate, attenuate, in fruit about 6^{mm} in length, scarcely striate, persistent, becoming dry and some-

what scarious: petals half to two-thirds as long, white, oblong, cleft only about a quarter of their length or even less, the teeth often unequal: stamens five: styles three: ovary globose: valves of young fruit three, bifid; seeds not seen.—*Alsine Jamesii* Holzinger, Contrib. U. S. Nat. Herb. **3**: 216, in part, *i. e.* as to no. 608.—Collected in flower July 8, 1892, on St. Joseph's river, Wiessner's Peak, Kootenai county, Idaho, at 1800^{m} altitude, by Messrs. Sandberg, MacDougal, and Heller, no. 608, and distributed as *Alsine Jamesii* from the Department of Agriculture.

This species has much the habit of the Japanese *S. Yezonesis* Maxim., which, however, is decandrous, has more deeply cleft petals and exhibits some other differences. *S. oxyphylla* is on the border line between Stellaria and Arenaria and indeed suggests at first sight *Arenaria macrophylla* Hook., although slight examination of the pubescence and calyx shows it to be quite distinct from that species, and, all points considered, there can be little doubt that its affinities are with Stellaria. It offers a drastic example of the deplorable haste with which the so-called reform of our nomenclature has at times proceeded; for the *Alsine Jamesii* of Holzinger, supposed to represent *Stellaria Jamesii* Torr., in reality rests upon a mixture of the very different *S. oxyphylla* (no. 608) and a luxuriant form of the cosmopolitan *S. media* Cyrill. (no. 78), species so widely diverse that it is truly difficult to see how the confusion could have occurred. It will be rather interesting to observe whether *Alsine Jamesii* Holzinger is to rest upon its synonymy (which by the way is not wholly correct, the original name being *Jamesiana*) and stand for a species which Mr. Holzinger may never have seen, certainly never examined, or whether as in other cases the name is to be taken as referring to the plants for which its author was actually using it.

Stellaria Washingtoniana.—Delicate annual: stems decumbent, leafy, branching from the lower nodes or often quite simple, pubescent with fine white spreading or slightly felted hairs; branches simple or nearly so: leaves ovate, acute, subpetiolate, thin and of delicate texture, not lucid, about 8^{mm} long, 5 or 6^{mm} broad, puberulent or glabrous, finely ciliate near the contracted petiolar base, 1-nerved but showing in transmitted light pinnate veins as well as an intramarginal one: peduncles two to several, axillary, solitary, filiform, pubescent, about 1^{cm} in length, spreading, 1-flowered: calyx

campanulate, externally pubescent; sepals four, ovate, 2 to 3^{mm} long, narrowed to an obtusish apex, delicate in texture, herbaceous except on the margins, obscurely 3-nerved: petals none: stamens eight: styles three, recurved: ovary and capsule ovoid; seeds dark reddish brown, minutely roughened.— Collected in flower and fruit in alder woods of the upper valley of the Nesqually upon slopes of Mt. Rainier, Washington, June 18, 1895, by Professor O. D. Allen and forming no. 157 of his valuable set of Cascade mountain plants; also collected but chiefly in a sterile state on clayey banks near Lake Cushman, August 1895, by Professor C. V. Piper.

The affinities of the species are obviously with *S. obtusa* Engelm., *S. crispa* Cham. & Schlecht., and *S. calycantha* Bong. *S. obtusa*, however, is essentially glaborus, and has thicker obtuser apparently glaucescent leaves and sepals, while *S. crispa* is wholly glabrous and has narrower attenuate sepals, which are more or less distinctly ribbed near the base. *S. calycantha*, on the other hand, bears at least its lower flowers in the forks of a distinctly cymose inflorescence.

ARENARIA ULIGINOSA Schleicher.— This species, long known, although somewhat local, in alpine and boreal regions of Europe, as well as in Siberia and Greenland, has been collected on slaty detritus near Rama, northern Labrador, at about 300^{m} altitude, by Mr. J. D. Sornborger, August 1897. While the species appears in Watson's Bibliographical Index, under the name *A. stricta*, it has not, to the knowledge of the writer, been hitherto observed upon continental America, its citation in the Index being due to the fact that Dr. Watson included Greenland in the territory covered, as well as to the circumstance that he included in his synonymy of the species in question the quite different *A. Rossii* R. Br. As will be seen from the accompanying *fig. 6* in *Plate XIII*, *A. uliginosa* can readily be distinguished from any of the related North American species by its foliage closely tufted at the base and by its very long and slender almost naked stems and peduncles. In these, as in all other observed characters, Mr. Sornborger's specimens correspond exactly with those from the Old World. The nature of the occurrence in Labrador, together with the presence of the

species in Greenland, leaves little doubt as to the indigenous character of the Labrador specimens.

This species has a rather complicated synonymy which has led to so much confusion that it will be best to cite its bibliography here in some detail. Its names have been as follows:

Spergula stricta Swartz, Vet. Acad. Handl. Stockh., **20**: 229. 1799; and in Schrad. Journ. 1800²: 256.

Arenaria uliginosa Schleicher, "Cent. exs. 1. n. 47," acc. to Lam. & DC. Fl. Fr. **4**: 786. 1805, where a good description is given; DC. Ic. Pl. Gal. Rar. 14 (excl. syn. in part), *pl. 46*; and Prodr. **1**: 407; Hook. f. Arct. Pl. 287, 322; Gray, Proc. Acad. Philad. 1863: 58; Hook. f. Stud. Fl. Brit. Is. ed 3. 63; Britton, Mem. Torr. Club. **2**: 37.

Alsine stricta Wahlenberg, Fl. Lapponica 127. 1812; Fl. Dan. *pl. 2962*; Nyman Conspect. 118, and continental authors generally.

Arenaria Lapponica Spreng. Syst. **2**: 402. 1825; Hook. f. & Jacks. Ind. Kew. **1**: 179.

Sabulina stricta Reichenb. Fl. Germ. Excurs. 789. 1832.

Stellaria stricta Sw. ex Steudel, Nomencl. ed. 2, **2**: 637. 1841.

Arenaria stricta Wats. Bibliog. Index 98. 1878, at least as to the first three synonyms.

From the above synonymy it is evident that there is a considerable choice of names and that the selection by different authors is likely to vary somewhat according to individual ideas of classification and nomenclature. It is clear, however, that those who unite Alsine and Arenaria and who also prefer the "first correct combination" must choose *Arenaria uliginosa*, the name current in England. It is to be regretted that the statements made in regard to this species in the *Index Kewensis* are most conflicting and inaccurate, being as follows:

Under Alsine

A. stricta, Mert. and Koch, in Roehl. Deutschl. Fl. iii. 278 = Ar. stricta.

A. stricta, Wahlenb. Fl. Lapp. 127 = Ar. lapponica.

Under Arenaria

A. lapponica, Spreng. Syst. ii. 402.— Lappon. [given as a valid species of restricted range].

A. uliginosa, Schleich. ex Schlecht. in Ges. Naturf. Fr. Berl. Mag. vii. (1813) 207 = Arenaria stricta.

Under Sabulina

S. stricta, Reichenb. Fl. Germ. Excurs. 789 = Arenaria stricta.

Under Spergula

S. stricta, Sw. in Vet. Acad. Handl. Stockh. xx. (1799) 229 = Arenaria stricta.

Now of these six clear references to this well-known European plant all are incorrect. Four refer it to *Arenaria stricta*, but the only plant of that name cited by the *Index Kewensis* is the common and wholly distinct American species of Michaux's *Fl. Bor. Am.* 1: 274, while the other two references to the plant under discussion maintain for it the name *Arenaria Lapponica* Spreng. (1825), which is much antedated both in Arenaria, Alsine, and Spergula, and is accordingly supported by no code or usage whatever. As further incidents in this confusion may be mentioned the neglect of Lamarck & De Candolle's early publication of *Arenaria uliginosa*, and the omission of Watson's *Arenaria stricta* which, as its synonymy clearly shows, was employed in a sense wholly different from *A. stricta* of Michaux.

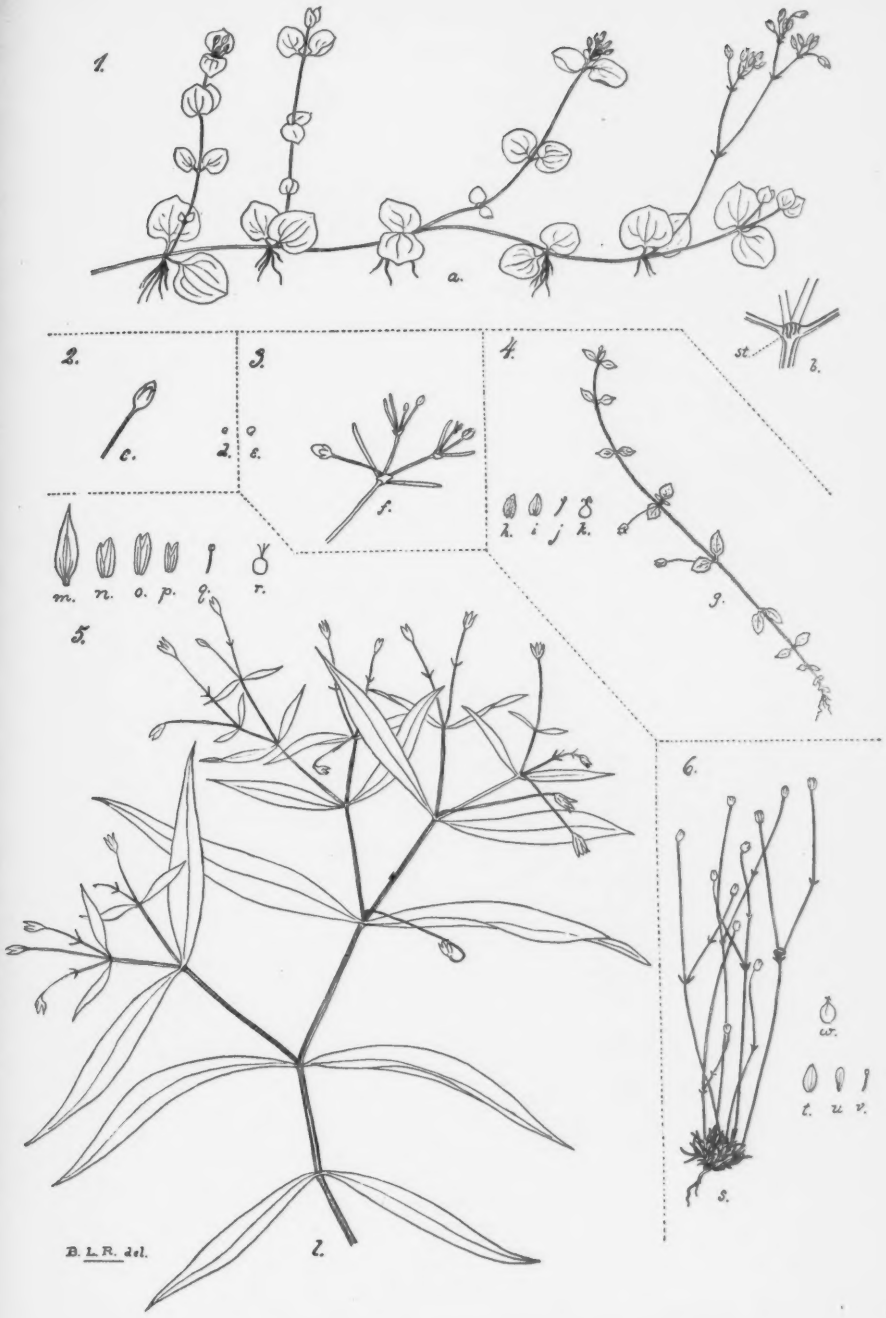
In 1890 (Mem. Torr. Club 2: 37) Dr. N. L. Britton exactly expresses the position of the present writer, by his footnote, which runs as follows:

"*Arenaria stricta*, S. Wats., Bibliog. Index, Polypet. 98 (1878), is based on *Spergula stricta*, Sw. Act. Holm. xx. 229 (1799), which is *Alsine stricta*, Wahl. Fl. Lapp. 127 (1812), and the oldest name available for it appears to be *Arenaria uliginosa*, Schleich. Dr. Watson's binomial of 1878 can in no way displace Michaux' of 1803."

This position, stated so positively by Dr. Britton in 1890, is of course quite contrary to the unwise Madison rule of 1893, which asserts the immutability of an older specific name even when the species is transferred to a genus already containing an identical specific name of later date. As the writer has elsewhere shown, this provision, together with the dictum of "once a synonym always a synonym," would give a power to any thoughtless worker of displacing forever many valid specific names. Such a rule can certainly never attain general acceptance, and it is a pleasure to see from Dr. Britton's note of 1890,

how clearly he sees its disadvantages. Nevertheless it is a matter of surprise to note that he did not feel impelled to follow the Madison rules in the *Illustrated Flora*, nor even in the *List of Pteridophyta*, etc., (which was expressly prepared to illustrate the nomenclatorial system of the American Association), for in both works *Arenaria stricta* Michx. is still kept up, although the Madison rule would clearly establish *Arenaria stricta* (Sw.) Wats. for the European plant and force the adoption of *A. Michauxii* Fenzl. for the American. Dr. Britton's usage can scarcely be due to oversight, for he had so recently shown a complete understanding of the existence and distinctness of the two species concerned. But if, on the other hand, it is to be taken as a very sensible exception to an undesirable rule, it may be asked: What is to become of a rigid system, if even very sensible exceptions are permitted?

SPERGULARIA BOREALIS Rob.—Until recently this species has not been known south of Wells, Maine, where collected by Mr. Walter Deane. However, President E. Brainerd has brought to the notice of the writer specimens collected at North Dennis on Cape Cod by the Rev. C. N. Brainerd, and still more recently specimens from the banks of Seekonk river near Providence, Rhode Island, have been sent to the herbarium of the New England Botanical Club by Mr. J. F. Collins. These more southern specimens agree in all observed points with the northern. The best distinctive features appear to be the short blunt sepals and large seeds. *Figs. 2* and *3* of *Plate XIII* will assist in distinguishing this species from *S. salina* Presl., the only member of the genus with which it is likely to be confused. An examination of the specimens of Spergularia in the herbarium of the Middlesex Institute, recently deposited in the herbarium of the New England Botanical Club, shows that *S. borealis* also grows on the salt marshes of the Mystic river, near Medford and Everett, Massachusetts, where discovered and distinguished from *S. salina* by Mr. F. S. Collins. Upon this material rests the *Lepigonum medium* of Dame & Collins, *Flora of Middlesex County*, p. 16. Now that the species is known within easy reach of many local



ROBINSON on CARYOPHYLLACEÆ.

botanists, it is to be hoped that it will receive further field study, which may lead to the discovery of additional distinctive features.

DRYMARIA CORDATA Willd.—This common and well known species, widely distributed in the tropics of both hemispheres, but not, to the knowledge of the writer, hitherto reported from any part of the United States, has recently been collected on the banks of the Withlacoochee river near Istachatta, Florida, by Mr. A. H. Curtiss. Whether the plant is indigenous in this locality has not been determined. The seeds, which are of small size, may well have been brought from the tropics in mud clinging to the feet of migratory birds or in some such way. It appears that in warm countries this species is apt to be rather common, where it occurs at all, and the fact that it has not been observed in Florida before would rather suggest a recent introduction. *Fig. 1* on *Plate XIII* is drawn from a Mexican specimen, not from Mr. Curtiss' plants which, although unmistakably of this species, are sterile.

GRAY HERBARIUM.

EXPLANATION OF PLATE XIII.

The original drawings reduced one-half in the plate.

FIG. 1. *Drymaria cordata; a*, habital sketch; *b*, node showing cleft stipule *st.*

FIG. 2. *Spergularia salina; c*, old flower with mature capsule; *d*, seed.

FIG. 3. *Spergularia borealis; e*, seed, drawn to same scale as *d*; *f*, branchlet, showing at the left an old flower with blunt sepals and much exserted capsule.

FIG. 4. *Stellaria Washingtoniana; g*, fruiting plant; *h*, outside surface of sepal; *i*, inside surface of sepal; *j*, stamen; *k*, ovary.

FIG. 5. *Stellaria oxyphylla; l*, habital sketch; *m*, sepal; *n*, *o*, *p*, petals; *q*, stamen; *r*, ovary.

FIG. 6. *Arenaria uliginosa; s*, habital sketch; *t*, sepal; *u*, petal; *v*, stamen; *w*, ovary.

ON COLLECTING AND PREPARING FLESHY FUNGI FOR THE HERBARIUM.[1]

EDWARD A. BURT.

(WITH PLATE XIV)

OUR North American flora is so rich and its territory so large, in comparison with the number of botanists engaged in its study, that the knowledge of even the distribution of some large classes of its plants is very inadequate, being based chiefly on work covering comparatively limited regions. This is especially true for the fleshy fungi (Basidiomycetes and larger Ascomycetes), the larger number of which are rapidly putrescent and therefore not usually found in the collections of professional botanical collectors and explorers, to whom we owe so much in other classes. The larger herbaria and exsiccati are also, for the most part, comparatively poor in their representation of our fleshy fungi, exclusive of the more persistent Polyporeæ, Hydneæ, and Thelephoreæ. My personal observation leads me to believe, however, that there is no class of plants concerning which people who are not botanists would more gladly have a botanist's knowledge than of the class Basidiomycetes, and there is probably no class of plants whose collection and study in one's home locality can be carried on with greater interest for a series of years, provided one has sufficient freedom during the summer and autumn months to make collections when the weather conditions make these plants most abundant, to take full notes at the time of collecting and while the plants continue fresh, and, finally, to prepare and preserve his plants so that they may serve as a nucleus for comparison and study in following years. It is the aim of the present paper to point out

[1] Read before the Vermont Botanical Club February 5, 1898.

practical methods of doing this work so that it may afford results and collections of permanent scientific value.[2]

COLLECTING.— For collecting fleshy fungi, I have seen nothing better than a common splint basket with hinged cover (*fig. 1*), such a basket as is often used for a lunch basket at picnics or as a workman's dinner basket, and is to be obtained for twenty to thirty cents. My preference is for a size about $14^{in} \times 9^{in} \times 11^{in}$ deep. Such a basket is much lighter than a tin box; it is provided with a pair of handles by which it may be carried suspended from the arm; the cover protects the contents from injury by direct sunlight and, in going through woods and thickets, from injury by branches. The convex cover is thrown back while one stops to make a collection and it forms a receptacle 3^{in} deep, very convenient for the temporary arrangement of the material. Fleshy fungi find too close an atmosphere in a tin collecting box and rot down much sooner than in the basket.

It is well to carry in the basket a chisel for the removal of species growing on wood, and a trowel-like knife for those growing deep in the ground or for those which it is desirable to carry home in the original clusters. One or two small tin or pasteboard boxes should also be provided to hold the more delicate and fragile species. The basket should contain a package of thin, but strong and tough, uncolored paper—a heavy weight tissue paper which does not become too tender when moist is good. This paper should be cut into squares and rectangles varying in size from 6^{in} square to $1^{ft} \times 2^{ft}$.

Whenever a species that is to be saved is found, it should be collected, if possible, in sufficient quantity for several ample specimens, pains being taken to obtain a full series of stages, both young and mature, and to take up each plant with as little injury as possible in order to show the base of the stem and any sclerotoid or radicated parts present. A sheet of paper large enough for the collection is then selected from the package and spread out in the open cover of the basket. The plants are

[2] Cf. Humphrey: The preparation of agarics for the herbarium. BOT. GAZ. 12:271. 1887.

arranged on the central portion of the paper so as to form a compact pile, and in this pile is placed a slip bearing the written field notes of this collection. The four corners of the sheet of tissue paper are raised and brought together above the pile and twisted together so as to draw the sheet closely about the pile of fungi and hold the plants firmly, forming a compact package in which the individual plants cannot be shaken about. These packets should be bedded closely together in the basket so that they may be carried without shaking. Very heavy specimens weighing several pounds each should be placed at the bottom of the basket preferably, or resting one on the other at one of its ends.

The fleshy fungi are very fragile, yet I have made many collecting trips in the rugged Green mountains, collecting in rough wooded places through the greater part of the day, and driving towards its close from five to twelve miles with my basket of specimens, or oftener carrying the basket knapsack-fashion on my back while riding a bicycle, and yet have found the plants in perfect condition in the packages when home was reached. During the annual field-day of our Botanical Club last September, Professor Jones and I collected fleshy fungi on the ascent up the west side and on the summit of Mt. Mansfield during the first day, and on the second day down the steep eastern slope through the forest to Smugglers Notch and through the Notch. Then there was a rapid ride over a rough road to Jeffersonville and a further ride of several hours by rail home. Our collections came through in fine condition, however, and gave a large number of interesting species a place on the state list. The paper wrapper about each package gives rigidity and elasticity to the contents of the basket, retains the original moisture of the plants well, and does not wholly prevent the circulation of air through the basket. If decay begins in any package, it is confined there. In addition to this, the great advantage of having each species with its field notes kept by itself, will be appreciated by every one whose work has been with the lower cryptogams.

FIELD NOTES.—Field notes are of great importance[3]; they should always be made for each species which one does not already know well, and also for any collection which impresses one, although in a vague way, perhaps, as strange or unusual. Such notes afford in many cases decisive characters in the determination of the species. Some characters are so evanescent that they cannot be made out after the plants have been kept a few hours; if there is to be any doubt about any such character, that doubt can usually be settled by five minutes search for a good plant much more satisfactorily and more easily than by perhaps hours of hard work in the consideration of technical descriptions.

In general, notes treat of viscidity, hygrophaneity, and field-dryness of the pileus; of the colors of the lamellae, if they differ in color in young and mature plants; of the presence of milk and its color and taste; of noteworthy characters of the stem, as viscidity, the presence of a cortina and its color in young plants, and of an evanescent ring or volva; and of the special habitat of species growing on wood, under pines, in swamps, open pastures, etc. These notes are quickly made, as positive characters are the only ones usually stated, although in some cases specific statement of the absence of distinctive characters is very helpful. The field notes should be placed at once in the package with the plants to which they refer.

CARE OF PLANTS PREPARATORY TO IDENTIFICATION.—As soon as possible after reaching home or the place where the further work of determination and drying is to be done, the packages of fungi should be removed from the collecting basket and distributed in other covered baskets so that the packages may stand closely together on the bottom of the basket but not usually resting one on the other. In this distribution, the packages containing the most putrescent fungi, such as species of Coprinus, Psathyrella, Panaeolus, Boletus, Flammula, Tricholoma, Hygrophorus, and Amanita, may with advantage be

[3] Cf. Underwood: Suggestions to collectors of fleshy fungi. Alabama Agr. Exp. Sta. Bulletin **80**: 271. 1897.

placed in a basket by themselves, as they should be the first identified and dried, or many will be lost by decay. The packages of less putrescent fleshy fungi may be kept fresh in fair condition for two or three days after being collected, but the difficulty in their study and determination increases with the time they are kept.

COLLECTING THE SPORES.— While distributing the packages from the collecting basket, at least one plant in each package should be set for spores, which may be collected very easily and without the sacrifice of a plant. Sheets of white paper and of black paper without a glossy surface are needed. If there is reason for believing that the plant bears white spores, a circular disk of the diameter of the pileus is cut with scissors from the black paper; this disk is then slit radially from the margin to the center, and enough of the paper is cut away about the center to give an opening of the diameter of the stem just underneath the pileus. The paper disk is then placed underneath the pileus in contact with it and with the stem passing through the opening made for it. The plant is then placed in erect position in the pile from which it was taken, and the other plants of the pile are arranged about this plant in such manner as to support it in erect position and also to hold the paper disk close up against the pileus. The four corners of the wrapping sheet are then brought together above the pile of plants and twisted together in the manner already described. The package of plants is then placed in the proper basket.

If the fungus is believed to have colored spores, the disk is cut from white paper. When the color of the lamellae causes doubt as to the color of the spores, set one plant for white spores and another for colored spores. In the case of species of Clavaria (exact knowledge of the color of the spores is necessary for specific determination in this genus) and of sessile and lateral stemmed pilei, it is merely necessary to lay one or more plants hymenial side downward on the spore paper in the pile and to enfold all again with the wrapper. The white paper may be obtained gummed and the spores will become imbedded in the

adhesive matter, giving a spore print from which the spores will not be rubbed away.

More elaborate methods of collecting spores have been proposed.[4] The above simple method has been found to work well and to require but a small amount of labor and no bell-glasses to protect from currents of air. It has also the great advantage of keeping all the plants of a collection together.

DETERMINATION OF THE SPECIES.— In this connection, a statement which I made at our meeting of last year may be repeated: "When material is plenty, it is not usually worth while to determine for the first time dried specimens of the fleshy fungi. After one knows a species and has it in his herbarium, it is not difficult to recognize the species in dried specimens; but first determinations of fleshy Basidiomycetes and Ascomycetes are best made on fresh plants." During the night spores will fall on the paper disks in sufficient quantity to show their distinctive color. On the second day, therefore, one should proceed with the study and determination of as many as possible of his collections, and he can do so with the assurance that the unbiased observations made and the positive knowledge thus far gained will materially lessen the labor of his further study and contribute to the accuracy of his final determinations.

Many of the collections will be traced through to their species with but little trouble — this is especially true for the better known species of world wide distribution or of economic importance — and one will feel sure of the correctness of his determination. For such cases it is perhaps only necessary to add in addition to the usual data of specific name, date, locality, and details of local environment or habitat, a concise statement of the characters by which the plant is referred to the particular species, of the flesh and its color, taste, odor, and change of color when wounded, and of the characters already noted in the field notes. If the plants have been found to agree with a reliable plate of the species, record should also be made of the plate. In most

[4] HARZ in Botanisches Centralblatt — : 78. 1889. Translated in Jour. of Mycology 5: 163. 1889.

cases these data may be given in the regular herbarium label, but in some instances it may seem best to use a larger slip.

Difficulty will be experienced in determining some of the collections, or some collections may be referred to rare or little known species. In all such cases full descriptive notes should be made of all characters of the plants. These notes should treat of the pileus with regard to form, surface, moisture, color, hardness, and size; of the lamellae, tubes, or other hymenial surface with regard to relation to the stem, relative distance apart, connection with each other, waxy surface, surface studded with drops, color, form, and breadth; of the spores with regard to color, surface, form, and dimensions; of the stem with regard to structure, surface, coloration external and internal, form, dimensions, base, presence of a volva, ring or cortina, and its color and persistency; of the flesh with regard to color, taste, odor; of any change of color which any part may show on being cut or bruised; of the presence of milk and its taste and color; of the mode of growth of the plants, whether solitary, gregarious, or cespitose; of the kind of soil in which they grew or on what kind of wood, or other substance, and whether in woods and their kind, or in open fields; and also of locality and date; and of any other matter of which record seems desirable.

A suggestive outline for these full notes is afforded by the blank for collectors' notes in use by the members of the Boston Mycological Club. This blank also affords great help to the beginner by giving the usual scientific terms in which descriptions are couched.

An earnest attempt should be made to determine each species of which one makes an ample collection. From an ample collection one is not likely to conclude that an individual variation or abnormality is a constant character of the species. If the attempt at determination fails for the time being, the dried plants accompanied by full descriptive notes will usually make identification possible later on. Species not readily determined at the time often prove the prizes of the trip.

DRYING.—Well dried plants in ample amount, carefully pre-

pared for the herbarium and accompanied by accurate notes of the characters of the fresh plants generally afford the most satisfactory specimens for the herbarium. If such specimens can be supplemented by photographs, sketches, drawings in color, sectional preparations, or specimens in alcohol, so much the better. In a few genera and one family, the Tremellineae, which dry poorly, alcoholic specimens are to be preferred, but in general well dried plants properly prepared are very satisfactory; they are convenient for reference also and do not occupy too much space.

A good herbarium specimen of a basidiomycete should show not only its external form, surface and habit but also its internal structure. Some plants should therefore be split lengthways into halves with a sharp knife or scalpel. If skillfully prepared one of these halves will show the thickness of the pileus, breadth of the lamellae, relation of the lamellae to the stem, structure of the stem, and sometimes the color of the flesh. Earth adhering to the base of the stem should be carefully removed, pains being taken to leave uninjured the whole base of the stem with its volva and radicated portions, when these are present.

The primitive mode of drying fleshy fungi is by the heat of the sun. This method gives good results with a few genera, but it is not available during the night and on cloudy days. At its best, it is so slow that thick, fleshy species of such a genus as Boletus become so decayed and so eaten by larvæ that the stem usually separates from the pileus and the tube characters become almost lost.

A better method is to place the fungi in a wire basket and suspend this above a stove. This gives good specimens if the heat is maintained night and day. During the summer the kitchen range is likely to be the only stove in which a fire is kept going. Now, many of the fleshy fungi which one will dry contain insect larvæ; as the plants dry out these larvæ literally drop from the frying pan to the fire. It is evident that the mycologist may encounter serious domestic obstacles in his attempts to use the range.

For some time I have been using a preferable method which I devised during my student days in order to save my collections. My Vermont collections of the last two seasons have been dried in a galvanized wire tray $14 \times 20 \times 2^{in}$ deep (*fig. 2*). This tray is suspended horizontally 16^{in} above the floor against the side wall of a room by strong cords tied to the four corners of the tray and passing over a nail higher up in the side wall. As soon as a species has been determined, its characters noted, and the plants prepared as already directed, it is placed in a pile by itself, with its label, on the wire tray in the most favorable place available. An ordinary kerosene hand-lamp, total height 11^{in}, is placed under this pile of fungi of one species, or more usually under several piles grouped side by side, if several species are drying at the same time. The flame of the lamp is adjusted so that the current of heated air which rises up through the plants will not be hot enough to bake them. Species not subject to the work of larvæ, and which would make fine specimens by slow drying by sun heat, may be placed at places on the tray not directly above the lamp. As the piles of plants accumulate on the tray, more lamps are lighted and placed beneath it. Three lamps are sufficient for a tray of the area of mine. The lamps are kept going night and day until all plants on the tray are thoroughly dried.

During the process of drying the brittle stems of many species become pliant for a time. While in this condition it is a good plan to bend them near the point of attachment to the pileus so that they may lie in nearly the same planes as the pilei. Most species dry out rapidly in a few hours; others, as large Boleti and Lactarii, may require twenty-four hours, and may require turning once or more. As rapidly as plants are thoroughly dried in any piles, I remove such plants from the drying tray and place them, each species by itself, on the thick sheets of felt paper which are used as "driers" for flowering plants. During the busy collecting season my plants lie in the piles on these driers, from half a dozen to twenty species to a drier, in a room where they will not be disturbed. They may

be stored temporarily in paper bags or boxes, one species collection to a bag or box, and with each is kept its label, notes, and spore print.

PREPARING THE ROUGH-DRIED PLANTS FOR THE HERBARIUM.— During the process of drying, many fungi bend and curl into very unnatural and irregular shapes. In their rough dried condition they cannot be distributed in the sheets of an herbarium. They have first to be moistened and then flattened and kept in that condition until they are dry again. This part of the work may be done at one's convenience.

I moisten the plants by placing them in a moist chamber, leaving them there until sufficient moisture has been absorbed so that they can be bent without breaking. I use for this purpose a dry goods case made of matched boards. The inside dimensions of the case are $27 \times 20 \times 16^{in}$ deep. It is large enough so that two dryers with their loads of dried fungi may be placed side by side in the bottom. Cloths dipped in water and wrung out so as not to drip, are hung in a curtain-like manner inside the case against the side walls. Another wet cloth is spread across the open top of the box and the board cover is placed over this. Most of the smaller species absorb sufficient moisture in two or three hours, but large species of Boletus, Lactarius, and Russula may need to be left in the moist chamber over night or even longer. A damp cellar will serve the purpose of a moist box.

In the pliant condition the stem and pileus may be bent by the fingers so that both lie in the same plane, and the pileus may be given a more natural form than it assumed in drying. Care must be exercised to do no violence to any part, nor to separate the lamellæ from the stem. When shaped for the herbarium, the plants must be prevented from curling in drying. This is accomplished by placing them in folded sheets of unsized paper between driers, placing these in a pile with the least weight on the pile sufficient to prevent curling. This is not *pressing* the plants, as that term is used with reference to flowering plants; it is simply preventing their curling out of shape

while parting with the absorbed moisture. Pressure would crowd the lamellæ close together and crush them against the pileus, obliterating one of the most distinctive features of the fungus. In a well prepared specimen, unless the lamallæ are very broad, one should be able to look between them to the under surface of the pileus and make out venose connections if present.

If the plants are to be poisoned with a solution of corrosive sublimate or of strychnin, the poisoning should be done just before placing the specimens between the driers.

MOUNTING.—They will be dry enough for mounting after they have lain two or three days between the driers. Species sheets of standard size will be found preferable to half sheets for an herbarium of fleshy fungi. If the collection is small, it may be placed in an envelope of the Gray Herbarium style, and the envelope, bearing its label, should be glued to a card of somewhat larger size near its lower end (*fig. 4*, lower right hand corner). Sheets of mounting paper may be cut into halves, quarters, eighths, etc., for the cards. If the specimen is not scanty, two typical plants should be glued to the upper part of the card, one showing the upper surface of the plant and the other its under surface. These plants outside the packet facilitate comparison when referring to the herbarium, and they also catch the eye as one turns the sheets, and help to keep the species well remembered (see *fig. 4*, upper left hand corner).

The small card bearing the collection, part on the card and the remainder loose in the envelope, should be pinned to the species sheet at some place which will aid in keeping flat the pile of sheets of the genus. The several collections or specimens of the same species may be advantageously pinned to the same species sheet. If the collection is very large, a large envelope of the style used by Ellis in N. A. Fungi and Fungi Columbiani will hold the specimens from falling out better than the Gray Herbarium kind.

By this method the whole collection is kept together as a specimen in the herbarium. A specimen is not likely to be too ample. If some plants can be spared from it for exchanges,

they may be conveniently kept in the original collection until they are needed by others, and in the meantime they do not detract from its value for consultation. This does away with unmounted duplicates except in the case of large, woody Polyporeæ and Hydneæ.

Bulky specimens of Polyporeæ and Hydneæ and also collections of puffballs, etc., may be stored, each species or collection by itself, in small boxes of suitable size and the small boxes in larger boxes having the length and the breadth of a genus cover and a depth of 1¼, 2½, or a greater number of inches. These boxes are a great convenience. They may be kept in the regular pigeon-holes of herbarium cases, distributed among the families of which they contain specimens. In case of a specimen to be looked for in one of these boxes, a reference to the box in which it is kept should be given on the regular species sheet where one looks first.

SECTIONS OF FLESHY FUNGI.—In general, sectional preparations are regarded as of secondary value as compared with well dried and carefully prepared plants accompanied by good notes, but when well made and given in addition to the dried plants and notes, they add greatly to the value of the specimen. A full set of sectional preparations includes a median longitudinal section through a mature plant, the outer layer of the stem for the whole length of the latter but for only one-third of its circumference, the outer layer on the upper side of the pileus, and a spore print. If the plants are cespitose in growth, several median sections of different plants of a cluster will be grouped together. Median sections of young plants will also be needed in some cases to show inrolled margin of the young pileus, attachment of the veil, etc. The median longitudinal section of a mature plant is usually the most important preparation of the set. It must show faithfully the structure of the stem, the degree of attachment of the lamellæ or tubes to the stem, the breadth of the lamellæ or tubes, the thickness of the pileus, and the outline of the plant. No carelessness or inaccuracy in any respect, as, for example, omission of the stuffing of the

stem, can be tolerated, as it makes the preparation directly misleading.

A thin-bladed knife or scalpel with a keen edge is used for cutting these sections, which must be cut very thin. The sections, as cut from the fresh plants, are arranged as naturally and artistically as possible on the gummed side of a rectangular piece of gummed paper just large enough for them. A piece of waxed paper such as florists and confectioners use is laid over the sections and it must also cover all the exposed gummed surface of the gummed paper. The combination of gummed sheet, sections and waxed paper is placed between sheets of light weight blotting paper and driers in a plant press and dried rapidly under heavy pressure. The sections adhere to the gummed sheet, retain their colors better than by any other method with which I am familiar, and do not shrink much in drying. When they are quite dry, the waxed paper may be lifted from the preparations and the gummed sheet. I glue the back of the gummed paper at the corners against the upper part of the card bearing the envelope of dried plants of the same collection, as shown in *fig. 4*, with the collection at the right hand corner of the species sheet.

Herpell[5] has given full directions in regard to preparing sections of fungi and he has also issued a fine set of such preparations.

PRESERVATION OF FLESHY FUNGI IN THE HERBARIUM.—The dried fungi may be poisoned with dilute solutions of corrosive sublimate or of strychnin by the methods in use for flowering plants. In Rep. N. Y. Mus. **24**: 43. 1869, Mr. Peck gave the formula for a solution of corrosive sublimate, sulfuric ether, turpentine and alcohol which he was then using on the specimens in the N. Y. State Herbarium. This solution has not worked well in use, and in its stead Mr. Peck kindly permits me to give his formula for a strychnin preparation which he is now using and finds more satisfactory in all respects.

[5] Präpariren u. Einlegen der Hutpilze fur das Herbarium. Berlin. 1880; Sammlung präparirter Hutpilze. St. Goar. 1881–1884.

Strychnin poison mixture:

Sulfate of strychnia	⅛ oz.
Warm water	4 or 5 oz.
Alcohol	about 2 oz.

Dissolve the strychnin in the warm water; add alcohol to the solution until the mixture becomes thin enough to spread easily and to penetrate the specimens. The simple aqueous solution is not absorbed readily or spread easily, manifesting a tendency to gather in globules like mercury. The addition of the alcohol overcomes this difficulty.

A thorough application of the poison should be made with a soft brush to every portion of the surface of each plant. The application can be made with the least labor when the moistened plants, after being shaped for the herbarium, are about to be placed between the driers. As the poison does not penetrate to any great depth, "moth balls" (napthaline, camphorine, etc.) are often placed in the boxes with specimens of very thick and bulky fungi, such as species of Fomes and the like, to keep away insect visitors.

My herbarium of fleshy fungi is stored in insect proof tin boxes. These boxes (*fig. 3*) are large enough to take genus covers and mounting sheets of the full standard size; they are 6^{in} high—larger than the usual herbarium pigeonhole, but this is an advantage as some genera are very bulky. These tin boxes have a well made drop door at the front end, which fits so well as to retain vapors of carbon bisulphide in the box for fully forty-eight hours. The boxes are kept in a herbarium case.

When my herbarium was transferred to these boxes, a small saucer containing about 5^{cc} of carbon bisulphide was placed in each on the pile of plants it contained. At the end of three days the saucers were removed. There has been no evidence of further insect work in the contents of these boxes. Since that time all the collections of the season and all specimens received by exchange are subjected to the vapors of carbon bisulphide for at least forty-eight hours before being distributed in the herbarium. I find the chief drawback to this method of storing a herbarium of fleshy fungi to be the great expense of the tin boxes, of which I now have forty-two in use. To make

space for future additions, I think of poisoning a portion of the herbarium, consisting of groups of genera least troubled by insects, and keeping this portion in the ordinary herbarium pigeon-holes.

MIDDLEBURY COLLEGE, MIDDLEBURY, VT.

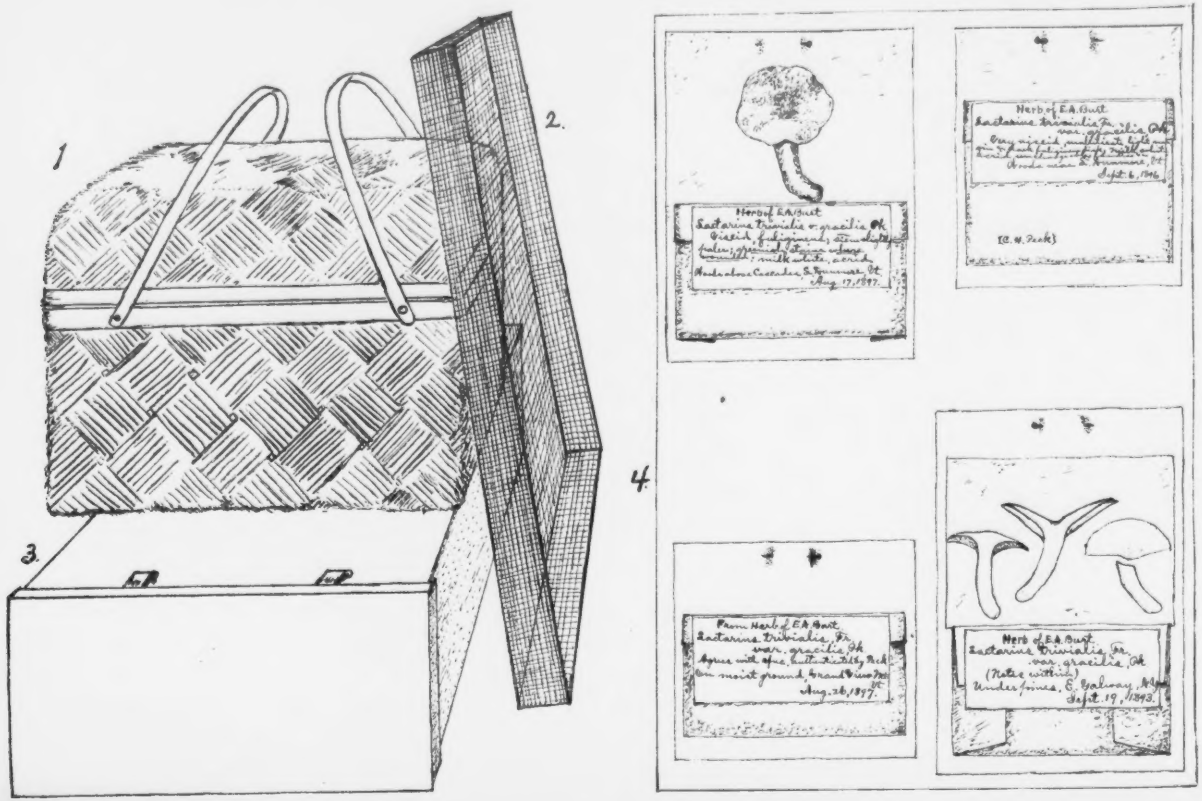
EXPLANATION OF PLATE XIV.

FIG. 1. Collecting basket.

FIG. 2. Drying tray of galvanized wire of ¼ in mesh.

FIG. 3. Insect-proof tin box for storing the mounted fungi. This is intended to take the place of the pigeon-hole in an herbarium case.

FIG. 4. Sketch of a species sheet of *Lactarius trivialis* Fr. var. *gracilis* Pk. from my herbarium, showing four collections each mounted on a card and the cards pinned to the sheet. The plants of each collection are loose in their respective packets, with the exception of that at the upper left hand corner of the sheet where one plant has been mounted outside the packet on the upper part of the card, and with the exception of the collection at the lower right hand corner where a set of sectional preparations on gummed paper is mounted on the upper part of the card.



BURT on COLLECTING FLESHY FUNGI.

ON SOME ASPECTS OF VEGETABLE PATHOLOGY AND THE CONDITIONS WHICH INFLUENCE THE DISSEMINATION OF PLANT DISEASES.

W. C. Sturgis.

The modern vegetable pathologist finds himself confronted at the very outset of his investigations by many preliminary questions which he is obliged to answer more or less satisfactorily before he can recommend with any degree of certainty a definite line of preventive or curative treatment.

He must be familiar with the main principles of vegetable physiology in general and the normal anatomy and histology of the special plant under consideration, in order that he may decide when and how the general course of the physiological activities of the plant is disturbed, and whether the structure which he observes is normal or otherwise. In case the anatomy is evidently morbid, he must be prepared to diagnose the case with as great a degree of accuracy as possible. Let us suppose that, as a result of extended observations upon one plant or a series of plants showing similar symptoms of disease, he finds that a particular organism is generally or constantly associated with the disease. I pass over the large class of cases in which no such organism is observed, and in which therefore the pathologist must put all his knowledge to the test, examine the environment with the utmost attention to detail, exhaust all his resources, and test every possible theory in his search for operative causes.

But, having found a possible connection between the diseased condition under observation and a living organism, the arduous portion of his work begins, viz., the determination of the parasitism or the mere saprophytism of the organism in question. For it is not enough merely to observe the associa-

tion of a living organism of fungous or bacterial nature with the diseased condition, no matter how intimate or constant such association may be. Of course, there may be cases, such as the "black-knot" of plum trees, in which the effect of the fungus is so apparent and its parasitic nature so manifest that the evidence of the unaided eye is almost conclusive (though even in this case it will be remembered that for years the knots were supposed to be caused by insects), but in the vast majority of cases a far more searching proof is necessary. The organism whose parasitic nature is in question must be isolated from its host and grown in a pure culture; thence it must be transferred with due care to the uninjured tissues of a healthy plant of the same species as that from which it was derived, growing under normal conditions; in this plant it must produce symptoms of disease identical with those originally observed; and, finally, from this plant the same organism must again be isolated. Only under the fulfillment of such conditions can an organism be stamped as an absolute parasite.

These are rules made familiar to us by the methods of modern bacteriology, but they too seldom enter into the practice of the vegetable pathologist. It may be said in passing that their fulfillment cannot always be attained. It is more than probable that only an extremely small proportion of the diseases of plants which are commonly attributed to fungous parasites are absolutely parasitic in their nature — that is, due to organisms which can attack and penetrate the uninjured tissues of healthy plants growing under normal conditions, and live therein at the expense and to the detriment of the host. In most cases the pathologist must be prepared to search for injured tissues offering an opportunity for saprophytic, followed possibly by parasitic attacks, or for unfavorable surroundings weakening the plant or rendering it peculiarly susceptible to the attacks of semiparasitic organisms. Such conditions are easily induced, and great care has to be exercised in drawing conclusions from results obtained in the laboratory or greenhouse from inoculations of wounded tissues of plants kept under conditions of warmth and moisture which

seldom, if ever, obtain in the field. The pathologist must be prepared to ascertain and to correct the predisposing as well as the apparent causes of disease, and among such causes he may even be forced to include the long process of artificial selection which has had as its almost exclusive aim the development of plants along lines of fruitage only, with too little regard to those factors which tend to produce hardy stock resistant to unfavorable conditions.

I make these statements with some hesitation, yet I believe them to be borne out by facts. It is becoming more and more apparent that in combating the host of fungi which invade our orchards and truck farms in these days of intensive farming, due regard must be paid to what we may call the hygiene of plant life. The proper regulation of the water supply by drainage and tillage; the securing of the free access of air and sunlight by pruning, thinning, and training; care in the selection of healthy, resistant stock; the intelligent use of fertilizers and their adaptation to the needs of the plant—these are some of the sanitary measures which, duly considered and acted upon, will do more than the mere use of fungicides to insure success in dealing with fungous diseases.

To take individual proofs of these general statements: Experiments recently conducted at the Rhode Island Experiment Station have gone far to show that the two most serious diseases of celery are due, not primarily to the attacks of the fungi associated with them, though both of them might properly be placed among Sorauer's "Schwäche-Parasiten," but to a weakening of the plants attributable to the purely artificial level method of culture whereby the roots are exposed to all the temperature-changes of the surface soil. A mulch, consisting even of the leaves of diseased celery teeming with the spores of the fungi in question, served to prevent the spread of the disease. That proper attention to purely cultural conditions will very largely decrease the prevalence of apple "scab" is a matter of common observation, and I have myself seen a peach orchard, showing the first symptons of a serious attack of *Cercospora Persica*, com-

pletely restored to health by tillage and a judicious application of nitrate of soda. I would direct the attention of every vegetable pathologist to the words in which Professor Bailey summarizes one of his bulletins on the care of orchards, and to the order of the terms which he uses, "Till, feed, prune, spray." I have outlined the steps which the vegetable pathologist must take in order to secure a trustworthy diagnosis. Having learned to distinguish a morbid condition through a working acquaintanceship with normal physiology and anatomy, he must determine the final cause of disease; by careful investigation he must decide whether it is parasitic or otherwise, and, if so, in what degree; and he must determine whether the attack of the parasite is immediate, or superinduced by the local destruction of tissues or by the general debility of the plant.

One very important question remains to be considered, viz., When and how the parasite, if such it be, secures entrance to the host and is thence disseminated. Upon the answer to this question depends in great measure the whole philosophy of preventive treatment. One method of determining the matter is, of course, the careful study of the life history of the fungus in question. If it be known, with a reasonable degree of certainty, that a certain pathogenic fungus depends largely upon aerial summer-spores for its dissemination, we naturally recommend preventive treatment with fungicides; if it is a perennial mycelium to which the fungus owes its continuous vitality, we are prepared to advise pruning. If it is ascertained that certain spores, seemingly delicate, are enabled to pass uninjured through an animal's digestive tract, the manure heap demands our first attention; and if careful research in the field and the laboratory is at length rewarded by the discovery of resistant spores produced during the winter in or upon the refuse of a diseased crop, we very properly lay the utmost stress upon a thorough cleaning up and destruction of all such refuse. A knowledge of such facts connected with parasitic fungi is absolutely essential to any intelligent application of preventive measures, and we cannot value too highly such researches as those of Thaxter upon "potato-scab," or of Aderhold upon the ascosporic forms of *Fusi-*

cladium dendriticum, and *F. pyrinum*. But fruitful results are also to be obtained by observations upon the direct means by which the reproductive bodies of parasitic fungi are borne hither and thither and become fresh sources of contagion.

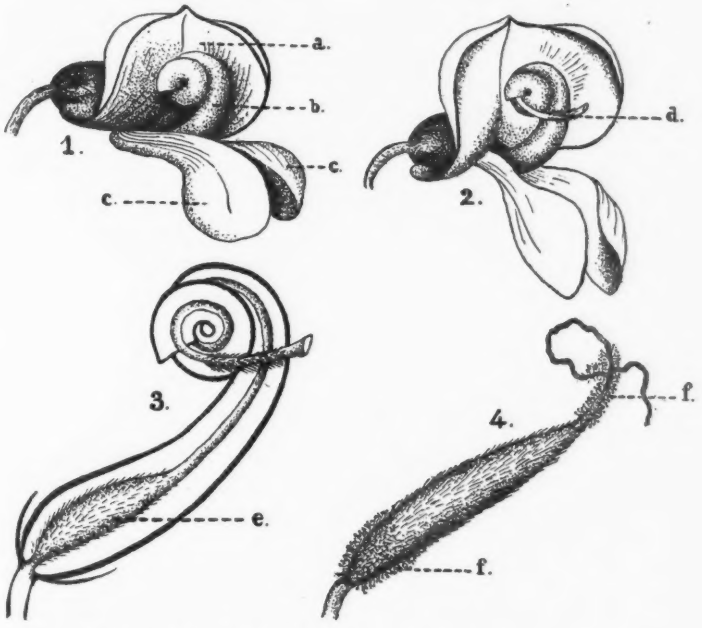


FIG. 1.—Normal flower of lima bean.
FIG. 2.—The same, with wing-petals depressed and style protruded.
FIG. 3.—Section of keel, showing the ovary and protruded style.
FIG. 4.—Young pod, showing mildew at the two extremities.

This leads me to speak of a rather striking case which came under my observation during the past summer. For several years the growers of lima beans in southern Connecticut have suffered great losses through the destructive attacks of the mildew, *Phytophthora Phaseoli* Thaxter. This fungus attacks the pods, sometimes covering them with its white, felt-like mycelium; it also occurs upon the leaves, though rarely and inconspicuously, and upon the fruiting branches where it does extensive injury by destroy-

ing the tissues below the flowers, thus causing the death of all the young pods above the point of attack. Before proceeding farther let us recall the structure of the bean flower. It will be remembered that the pistil and the stamens are completely enclosed in the spirally coiled keel (*fig. 1*). No portion of them is exposed to view except the very base of the ovary, and that only when the surrounding petals are forced apart. Under these conditions not only would close-fertilization seem to be assured, but it would appear certain that, however the mildew gained access to the host, it certainly could not be by infection of any part of the pistil before the fall of the flower. Yet, continuous observation convinced me that the mildew failed to appear to any serious degree before the flowers began to expand, that fairly mature pods seldom showed areas of fresh infection, that the young pods often showed a copious growth of fruiting hyphæ and spores indicative of infection before the fall of the blossom, and that the points of infection were always at the extreme base or tip of the young pods. These observations led to the supposition that insects were mainly responsible for the dissemination of the mildew.

Further investigation confirmed this view. I have called attention to the enclosed and protected position occupied by the pistil; this obtains until the flower is visited by an insect of considerable size, generally a honeybee. The projecting wing-petals offer a convenient landing place, and, as the bee alights on them, his weight deflects both wings and keel, the style is protruded from the keel, the bee's abdomen brushes over it, and in his efforts to reach the bottom of the flower the petals are forced apart, the base of the ovary exposed and the bee's head comes in contact with it (*figs. 2, 3*). Thus cross-fertilization is secured, but if the bee has, by chance, touched a mildewed pod with either head or abdomen, fungous infection no less surely occurs. It will be noted that the only portions of the pistil touched by the bee are the base of the ovary and the style. An examination of scores of flowers showed that in the majority of cases they were infected, and in these cases, without exception, the points of infection were identical with the spots touched by the bees (*fig. 4*). One

additional point might be mentioned. On a very badly diseased plantation it was noticeable that the spread of the mildew practically ceased about September 10, although the vines continued to flower and produce pods until October. I am at a loss to account for this sudden cessation of fungous activity, but it is worthy of notice in this connection that after the date above mentioned hardly any bees were seen in the plantation.

It seems almost certain then, that in the case of this mildew at least, insects are the principal agents in the dissemination of the fungus.

But I have already stated that the fungus sometimes appears elsewhere than upon the young pods. In some cases it is apparent from the respective positions of old and fresh points of infection upon the leaves or mature pods that the spores have been carried by the rain or dripping dew from one portion of the vine to a subjacent one, but certain facts led me to think that the wind played a considerable part in the infection of older tissues. In order to test this matter I pursued the following course. The mildew is usually confined to comparatively low, damp situations. The grounds of the Connecticut Experiment Station occupy an elevated position, the land is well drained, the soil light and sandy, and so far as I know, lima beans on this land have never mildewed. During the past summer they occupied two rows running east and west. Directly south of them, at a distance of about 100 feet, were two rows of bush limas running north and south (*fig. 5*). On August 14, when the mildew had been abundant for a month or more on a farm at a distance of about a mile in a straight line from the Station, the Station vines were carefully examined and found to be perfectly free from mildew. The following day two mildewed pods were brought from the farm above mentioned, and the mildewed surface of one of them was rubbed upon a single healthy and almost mature pod at the east end of each row of pole limas. The prevailing winds at the time and for the ten succeeding days varied from northwest to northeast. Within a week the mildew appeared abundantly upon the two infected pods and from this point swept down both rows from east to

west, and in two weeks the crop was practically ruined. Meantime the two rows of bush limas were examined daily. About ten days after the first infection of the pole limas, mildewed pods were found upon the bush limas, but only at the north end of the

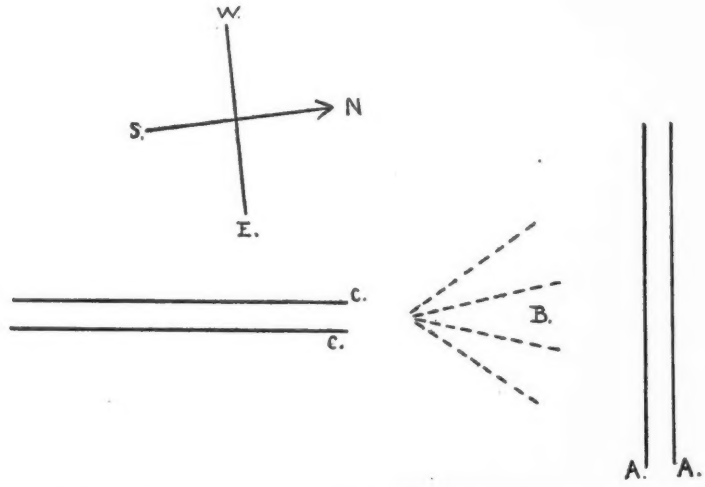


FIG. 5.—*A*, *A*, points of primary artificial infection on pole beans; *B*, course of prevailing winds; *C*, *C*, points of secondary natural infection on bush beans.

rows nearest to the source of infection. From this point it spread rapidly southward until both rows were completely involved.

The conclusion seems inevitable that not only do insects play an important part in the dissemination of fungous diseases, but that the wind certainly does its share.

How this particular fungus is propagated from season to season is a question of great importance, but it is apart from the object of the present paper which is to call renewed attention to the divers lines along which the vegetable pathologist is obliged to direct his attention, and the importance and interest which attaches to all observations relative to the dissemination of fungous diseases.

AGRICULTURAL EXPERIMENT STATION,
New Haven, Conn.

BRIEFER ARTICLES.

POTAMOGETON ROBBINSII.

(WITH PLATE XV)

THIS pondweed, first described by Oakes in 1841, is the rarest of the North American species to fruit, unless we except *P. interruptus* Kitaibel, which bears floral spikes quite freely, but is not known to mature fruit in this country, though it does in Europe. The principal mode of propagation of *P. Robbinsii* is by fragments of the stems, which root freely in the muddy bottoms of ponds and lakes where it grows, often forming dense patches covering considerable areas. Dr. Thomas Morong writes with regard to its fruiting as follows: "Very rarely, in years when the waters are low, the flowering spikes rise above the surface and perfect a few fruits. Dr. Robbins never saw but one fruit, which was collected many years ago in Oregon by Hall, and this was split in two, Prof. D. C. Eaton taking one half and Dr. Robbins the other. In the year 1880 Mr. Faxon had the good fortune to secure a few fruiting specimens in Jamaica Pond, Massachusetts. Besides them I have never known another instance, although the plant is very prolific in the localities where it occurs.[1]"

It was my good fortune in 1889 to find it fruiting in the Chesago lakes, Centre City, Minnesota, and a number of specimens were secured. This was in early September. Twice before during the same season plants were collected in the latter part of July in northern Michigan, at Republic, and in Goose lake near Negaunee. The specimen from Republic has a spike of fruit well formed, but immature. The superiority of the fruiting plants from the Chesago lakes, compared to those hitherto figured, has led me to have the accompanying plate prepared. It very accurately represents the average of the fruiting or upper parts of the stem, the lower very leafy portion, or that of barren shoots, not being represented. The specimens show an inflorescence loosely paniculate, the fruiting portion of the stems being 10 to 15^{cm}

[1] The Naiadaceæ of North America, Mem. Torr. Bot. Club 3: 54. 1893.

long, generally with four to nine or ten spikes. Some spikes get no farther than the floral stage. On others from three to six nutlets ripen, part of the flowers on them being aborted. One stem with eleven spikes in various stages of development had seven with perfect fruit, though not fully grown in all, aggregating about twenty-five nutlets. The largest number on a single spike is six. The spikes are 2–3^{cm} long, on slender diverging or erect-spreading grooved and angled peduncles, which are 3–7^{cm} (mostly 3–4^{cm}) long. The nutlets are 3–4^{mm} long by 2.5–3^{mm} wide. They are brown to reddish-brown in color, the surface minutely roughened under a lens. They are three-keeled on the back, the prominent middle keel having a thin, sharp, slightly angled margin. There is a shallow central depression on each side, circular, or a little elongated longitudinally, with a diameter about one-third that of the body of the nutlet. The plants grew in shallow water, the upper parts of the inflorescence usually protruding above the surface. I am indebted to Mrs. Agnes Chase of Chicago for the drawings, which faithfully represent the specimens.— E. J. HILL, *Chicago.*

EXPLANATION OF PLATE XV.

FIG. 1. Upper portion of a fruiting stem, natural size.
FIG. 2. Fruit enlarged ten diameters.
FIG. 3. Section of fruit, showing embryo, enlarged ten diameters.

WYOMING JUNIPERS.

THE junipers of Wyoming, while not numerous, are interesting. Until recently these have been assumed to be all of one species, *Juniperus Virginiana* L. The common Rocky mountain form of this has recently been segregated by Dr. C. S. Sargent under the name of *J. scopulorum.* This species seems to require two years to mature its fruit, this fact being one of the points upon which, as I believe, this good species is founded.

Some other species of Rocky mountain juniper were known to be common in neighboring states, *J. occidentalis* Hook. to the northwest, *J. Californica Utahensis* Eng. to the west, and *J. occidentalis monosperma* Eng. to the south. That one or more of these may yet be found within the borders of this state is quite probable; in fact, when during 1897 a

HILL on POTAMOGETON ROBBINSII.

form common in the hills of the Red Desert was secured it was assumed to be one of the above-mentioned well-known species. In trying to name the specimens, however, it soon became evident that none of the extant descriptions would apply. To make sure that such was the case I secured from other localities material of closely allied forms, more

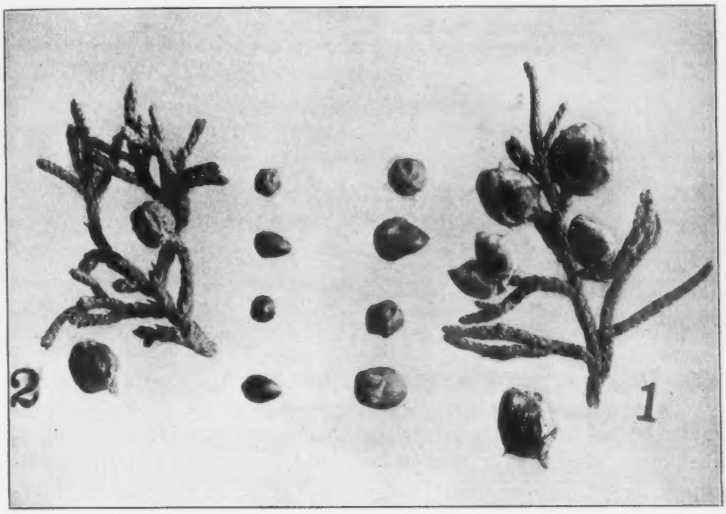


FIG. 1.—*Juniperus Knighti* Aven N. (1) and *J. Californica Utahensis* Engelm. (2).

especially *J. occidentalis monosperma* and *J. Californica Utahensis*.[2] The specimens agreed no better than the descriptions. *J. occidentalis monosperma* was excluded at once by its fleshy berry and small pointed seed. The new form was likewise to be distinguished from *J. Californica Utahensis* by difference in color, size, and shape of berry and especially by the seeds; also by the larger, plumper leaves. These differences are more or less well shown in the accompanying cut, where a bit of twig, some berries and seeds of the two are similarly placed and photographed (enlarged) on one plate as nos. 1 and 2 respectively.

The new form (no. 1) has not only the larger seed, but its obtuse

[2] For specimens and loan of specimens I am indebted to Messrs. T. S. Brandegee, J. G. Lemmon, and C. V. Piper.

only slightly grooved apex and its rounded swollen base will distinguish it from the other with its smaller, acute, brown-tipped seeds. Since it does not seem possible to place this with any of the already described forms, it may be named and characterized as follows:

Juniperus Knighti, n. sp.—A scraggy shrub or small tree, usually much branched from the base, *i. e.*, trunkless or breaking up into sev-

FIG. 2.—*Juniperus Knighti* Aven N.

eral subequal trunks also freely branched, branches widely spreading, the lowest close to the ground and almost resting upon it, round-topped, 3–7^{m} high or possibly in places exceeding this: leaves three-ranked, closely appressed, of rhomboidal outline, subacute, about 1^{mm} wide, nearly twice as long, thick, sometimes slightly depressed on the dorsum, entire or rarely minutely denticulate, neither pitted nor glandular, persisting in part on the branches of old trees as dead somewhat acute or acuminate scales, branches of young trees almost smooth or with a few long-acuminate scattered scales with usually a whorl of the same at the base of the branchlets; the branches divaricate but not squarrose: peduncle or fruiting branchlet short and thick: berry-like cones blue-green or copper colored (all distinctly copper colored if boiled), distinctly marked on the surface by the apices of their several scales, broadly oval, 7–10^{mm} long, dry, the coalesced scales thin, in dried specimens closely and tenaciously adherent to the large single seed: seed ovate, obtuse, slightly grooved above, rounded or swollen at the base: fruit possibly not maturing till the second year. —Type specimen, Herb. Univ. of Wyo., no. 3096, Point of Rocks, June 1, 1897.

It is with pleasure that I dedicate this species to Professor W. C. Knight, geologist and palæontologist and whilom botanist, to whom I am often indebted for specimens, and who first called my attention to this form.

This shrub-like tree is common in the so-called cedar bluffs, red sandstone hills, occurring at intervals throughout the Red Desert region of Wyoming from the Seminoe mountains to Green river. It was observed by the writer in numerous localities during the summer of 1897, the accompanying figure being from a photograph secured at Point of Rocks. The habit as shown is not only characteristic but nearly universal. One is reminded of the recently published illustration of Dr. Sargent's *J. scopulorum*,[3] which is scarcely characteristic of that species as I know it in the hills about Laramie.

The two foregoing are the only tree-like junipers that have yet been secured in the state, but one or two others may possibly be found within our borders to the west and north. Of the shrubby forms the following are abundant: *J. communis* L., *J. communis Sibirica* (Burgsd.) Rydb., and *J. Sabina* L.—Aven Nelson, *The University of Wyoming.*

THE MORPHOLOGICAL SIGNIFICANCE OF THE LODICULES OF GRASSES.[4]

The question of the morphological significance of the lodicules in the grasses has been discussed by very many botanists during the last hundred years. The last author, of which I know, to deal directly with the subject was Dr. Edward Hackel, the eminent agrostologist, who in his paper published in the first volume of Engler's *Botanische Jahrbücher* (1880), treats the question so exhaustively that his conclusions, supported as they are by his careful researches and to some extent no doubt by his great reputation as a student of the grasses, have for more than twenty-five years been accepted as the true interpretation of these organs. A glance at his historical résumé shows that, in the main, two views have been held by botanists: first, that these organs constitute a rudimentary perianth, to which view a considerable number, especially of the older botanists, gave adherence; and second, that they are remnants of bracts in morphological value the equivalent of leaves. To the latter view Hackel, as well as other earlier writers, held.

[3] Garden and Forest 10: 423. 1897.

[4] Read at the Ithaca meeting of the Society for Plant Morphology and Physiology.

It is important at the outset to point out that in other orders of monocotyledons the problem would be less important and indeed less easy of solution, since there frequently occur in them species exhibiting a complete transition from the bracts of the flower cluster to the leaves of the perianth. In the grasses, however, the true leaves are always distichous, while the sporophylls of the gynoecium as well as the androecium are in threes. The interpretation must mainly depend then upon the demonstration of the trimerous disposition of the lodicules on the one hand, or on their distichous arrangement on the other.

Either interpretation may presuppose the suppression of whole whorls or of parts of whorls or of bracts; the union of parts of the same set; the adhesion of superimposed sets or superimposed leaves. Hackel studied first the development of the lodicules on a considerable number of species, mostly European; second, he made a comparative study of mature lodicules; and third, he studied their anatomy. His conclusions are as follows:

1. "The anterior lodicules are to be regarded as the lateral halves of a leaf alternating with the palet (Vorspelze), the middle part of which only in rare cases develops either partly or entirely.

2. The anterior lodicules, arising as they do from a single simple rudiment (Anlage), experience in their growth various arrests through the more rapid growth of neighboring organs; they develop very often on their posterior border outgrowths in the form of teeth and lobes which, taken together with the before mentioned conditions, lead sometimes to the lodicules appearing dissected into distinct and even into superimposed lobes, whereby the appearance is sometimes presented of an aggregation of lodicules from separately inserted leaf structures.

3. The anterior lodicules are independent of the palet, although they sometimes unite mechanically with its margin, however, without organic union; they too develop later; are inserted higher on the axis than the palet; and in their tissue structure differ widely from it. The delicate bundles of the lodicule do not unite with those of the palet but join the axillary bundle independently. Lobes and stipular structures of the border of the palet, which sometimes occur, need never be confused with lodicules.

4. The posterior lodicules of the Stipaceæ investigated, and probably in all grasses where they are present, are really later to appear

than the anterior and are also probably inserted somewhat higher on the axis. Consequently the lodicules, when all are present, continue the distichous arrangement of the palet and glume."

In accordance with these conclusions, Hackel formulated his interpretation of the organs of the flower in grasses. It may be noted that Hackel expresses doubt about his interpretation of the significance of the posterior lodicule.

Usually the bamboos have the posterior lodicule present and, in a few species, there normally develop two trimerous whorls of lodicules. Last summer a bamboo (*Arundinaria falcata*) produced flowers in the University garden and the writer took the opportunity to study the flowers in detail with special reference to Hackel's conclusions.

Warming in his *Systematic Botany* (p. 291) regards the Bambuseæ as the most primitive of the tribes of the Gramineæ, and it seems to me that a fair consideration of their floral structure and their geographical distribution bears out his opinion. He also states the theory of the grass flower substantially as the writer is about to present it, but he gives this theory in brackets after having in the preceding paragraph given the bract theory in italics. If the bamboos be the most primitive of the grasses, then surely the lodicule in this group of plants ought to shed light on the question of their morphological significance.

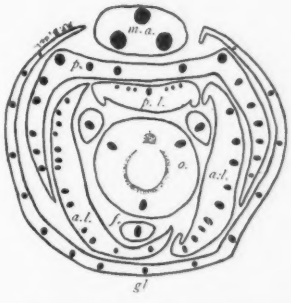


FIG. 1.—Cross section of flower of Arundinaria with subtending glume and palet: *m. a.* main axis; *gl.* flowering glume; *p.* palet; *a. l.* anterior lodicules; *p. l.* posterior lodicule; *f.* filament; *o.* pistil.

Serial cross and longitudinal sections of the flower were made and *figs. 1* and *2* are representations of what was found.

There occur in the ovary walls the three midribs of the coherent

carpels. That these are midribs is the more certain since the suture upon which the single ovule is borne is midway between two of them. The ovule is borne upon the posterior side of the ovary. The stamens in this species stand directly opposite the midribs of the carpels. The

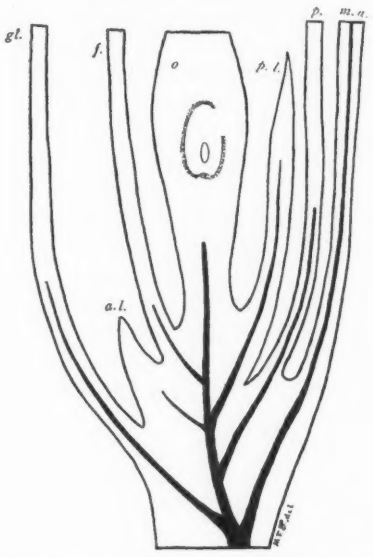


FIG. 2.—Longitudinal section of flower of Arundinaria, with particular reference to the insertion of the vascular bundles of the lodicules. Lettering same as in *fig. 1*.

inner whorl, present in some species of bamboos, is suppressed here. The lodicules alternate with the stamens and may be considered therefore the inner whorl of the perianth. The lodicules are all alike in form and in structure. The anterior ones do not give the impression of being "the lateral halves of a leaf." Their inturned margins, symmetrically distributed bundles, narrowed base, and trimerous arrangement with the posterior lodicule, make it very certain that they are foliar units, the equivalents of petals. As to the height of insertion of the posterior lodicule, there can be no doubt but what, in our plant, it is inserted higher on the axis than the anterior ones. This condition might reasonably be expected where organs are crowded together so closely as on the posterior side of this flower. That the place of inser-

tion is of little importance in this regard is shown by the fact that the palet also is inserted above the anterior lodicules. Tracing down the vascular strands of the three lodicules, they are found to unite with the central strand of the axis at approximately the same point, while the vascular strands of the palet unite with the axial strand below the insertion of the strands of the lodicules. The insertion is disguised by the adhesion of the palet to the posterior lodicules.

Hackel in his discussion neglected the general law which governs the arrangement of leaves on a branch among the grasses. As is well known, the leaves on a branch are inserted in a plane at right angles to the plane in which the leaves on the main axis are borne. Hackel's conclusions reverse this law and maintain that the leaves (lodicules) on the floral branch are in the same plane as the leaves (glume and palet) on the primary axis. Such a departure from normal arrangement is scarcely probable.

It seems to me that Hackel attaches too much importance to the fact that the lodicules appear as a single rudiment afterwards becoming two-lobed. The rudiment (Anlage) of the corolla in a great many plants arises as a continuous collar of the receptacle, and afterwards the lobes are differentiated.

The question is one of considerable moment. Taking one view there is more reason for believing the grasses a group connected by intermediate forms to other monocotyledons; taking the other, the grasses must stand as a more isolated group, and the recent assumption that they are but very remotely connected genetically with other monocotyledons would have more to support it. The question also bears on the primitive character of the bamboos. — W. W. ROWLEE, *Cornell University.*

OPEN LETTERS.

A REPLY.

At the close of a review of one of my papers in the GAZETTE, January 1898, p. 67, there is a statement which reflects on me in such a way that silence would virtually imply admission of the charges. I am therefore obliged, albeit reluctantly, to make answer. This statement is as follows: "There is a curious omission of reference to the researches of Dr. H. L. Russell on this disease, some of which have already been published, as well as those unpublished, of which Dr. Smith was fully cognizant. We reserve further comment on this matter until the publication of Dr. Russell's paper, of which advance sheets have reached us." In general it is wisdom to hear both sides of an argument and to know something about the merits of a case before pronouncing judgment. I am satisfied that had the reviewer taken this ordinary precaution the above criticism would never have been written, and certainly never printed. Under the circumstances, I must beg to make an explanation.

My own studies of the parasite which causes the black or brown rot of turnips, cabbages, and allied plants, began in the fall of 1896, and have been continued uninterruptedly to date. During this time I have alluded to the subject or spoken at length upon it in seven public addresses, viz., before the Massachusetts Horticultural Society in Boston, March 1897; before the Washington Botanical Seminar early in 1897; before the Washington Biological Society, May 1897; before Section G. of the A. A. A. S. at Detroit, August 1897; before the Rochester Academy of Sciences, October 1897; before the Society for Plant Morphology and Physiology at Ithaca, December 1897; and, finally, before the Peninsula Horticultural Society at Snow Hill, Md., January 1898. Notices of a number of these addresses went into newspapers and journals. During the same time I have published three articles on this organism: first, an abstract of the address before the Biological Society of Washington;[1] second, a long paper in the *Centralblatt für Bakteriologie*, published in three parts, July 7, August 18, September 10, 1897;[2] and finally, from the U. S. Department of Agriculture, a Farmers' Bulletin,[3] describing the results of field studies and showing how the disease

[1] Science, **5**: 963. June 18, 1897.

[2] **3**[2]: 284, 408, 478. *pl. 1.*

[3] No. 68, January 8, 1898.

may be prevented. For the information set forth in these lectures and papers I am in no way indebted to Dr. Russell.

The paper reviewed in the GAZETTE was sent to the *Centralblatt* early in the spring of 1897. Proof on the whole of it was read and returned May 4. Some reprints of the paper were distributed in this country September 29 and the rest October 23. Up to the date of this writing (January 28) Dr. Russell has, on the contrary, so far as I know, not published any important information respecting this parasite *Pseudomonas campestris* (Pammel), in fact, he did not seem to know of Professor Pammel's paper until I called his attention to it. Whatever "advance sheets" the reviewer may have seen, I have not seen any, neither has the general public, nor do I know what their contents may be. The expression, "some of which have already been published," probably alludes to a paper by Dr. Russell, which was read at the Springfield meeting of the A. A. A. S. in August 1895. I was not present at that meeting and never learned orally or through writing as to the contents of this paper. I desired very much to read the paper, but it was withheld from publication, and the only abstract of any value which I have been able to find is in the Proceedings of A. A. A. S. **44** : 193. 1895. I might have alluded to this short abstract and would have felt compelled to do so had I been considering cabbage diseases in general, rather than writing a paper on a particular organism. This abstract I read carefully a number of times, but never found anything in it which in any way aided me in my investigations. The symptoms of the disease are not carefully described, it had not been produced by inoculations with pure cultures, and the author was evidently in error as to the common natural methods of infection as the following citation shows: "The disease is first noticeable in the axil of the lower leaves in the sulcus on the upper side of the petiole. This depression is usually filled with moisture and the disease often gains entrance at this point through the mechanical rents that are caused by the rapid growth of this succulent tissue." On the contrary, the disease due to the organism which I have studied is generally first noticeable at the margins of the leaves. He also stated that his rot "spreads rapidly in the loose cellular parenchyma" of the petioles, which is not true of *Pseudomonas campestris*. Finally, there is not a line as to what kind of an organism he was experimenting with. Subsequently Dr. Russell told me (November 1896) that he was at that time (1895) working with the "wrong germ," namely, with a white organism, and this probably explains why he withheld the paper from publication, and also explains why I preferred to pass over the abstract in silence.

Now, as to what I have learned orally or by correspondence with Dr. Russell, or from other people, concerning his "unpublished" work, so as to be "fully cognizant" of it. The whole thing can be put in a nutshell. How I first came to undertake the study of this organism is sufficiently set

forth in the first part of the paper reviewed. Not until my investigation was well under way and I had asked for and had received a second shipment of cabbages from Racine did I know that samples had also been sent to Dr. Russell, and that he had again undertaken to find out the cause of the disease. At no time have I visited his laboratory or seen any of his cultures or any of his experiments, or had any desire to know what he was doing. In November 1896, Dr. Russell visited my laboratory desiring, as he said, "to talk shop," or, in other words, to learn what I was doing. Some of his questions I answered, others I parried, as any other man would have done, not desiring to give away to another working in the same lines information relating to an unfinished piece of research. At that time he said he had secured no infections and was unable to get the organism to grow in beef broth. He obtained from me a few facts which probably were of use to him, namely, that I was still working on the disease, that my organism was yellow, and that it would grow in properly made beef broth. From him I received the statement that the organism which he was then studying was yellow, the other statements which I have given above, and the fact that the loss at Racine exceeded $75,000. I obtained from him no facts which in any way changed my plan of work, and no ideas which were of any value to me except the statement as to the approximate pecuniary loss at Racine, which statement I carefully refrained from using, depending rather on general statements furnished by cabbage growers. If Dr. Russell had any ideas at this time as to the mode of infection or other interesting peculiarities of the organism, they were not revealed to me.

This is all I knew definitely of Dr. Russell's work until ten months later (September 1897) after the publication of two-thirds of my paper and within a week of the appearance of the remaining part. He then informed me that he had also secured infections and was preparing a paper for publication. He volunteered, however, scarcely any information concerning the details of his work, and no information whatever of which I have made any use, neither did I ask for any, nor desire any.

Such are the sole grounds for the charge of omission to give credit for work already done, and of being "fully cognizant" of unpublished work. Dr. Russell, as I learned from a conversation with him in September 1897, seems to have gone away from Washington with the idea that I would drop work on the germ, but I did not designedly or intentionally give him any such impression.

It has always been my desire to give all work the fullest recognition. If any one has cause to accuse me of sins of omission, it is not Dr. Russell but Professor Garman, who published a paper three years before the reading of Dr. Russell's Springfield paper (*Agricultural Science*, July 1892, pp. 309–312) on a bacterial disease of cabbage, and which, if it did not go very far, is at least cautious, covers much the same ground as Dr. Russell's abstract, and is

a much more useful contribution to science. I omitted mention of this paper because no infections were obtained from pure cultures, because the two organisms which were isolated were not described so as to be identifiable, and finally, because I was describing a specific germ and not writing a general treatise on cabbage diseases of which there appear to be several due to bacteria. The one man who has written on this organism so that other bacteriologists can make something out of his writings is Professor L. H. Pammel, to whom I gave full credit. Since the paper in question was written I have removed the final shadow of doubt respecting the identity of the organism which Professor Pammel described and the one I have studied, by the discovery that whether it *does* or *does not* liquify gelatin is an accident depending entirely on how the gelatin is made.— ERWIN F. SMITH, *Washington, D. C.*

[WE PUBLISH the above at Dr. Smith's request. Dr Smith could hardly have written it had he awaited the promised comments when Dr. Russell's paper was noticed (see p. 211). The reviewer was cognizant of the facts which Dr. Smith relates above (and some others) when the statement he quotes was written, and sees no occasion to change his judgment. It was as far from his thoughts then as now to charge Dr. Smith with improper use of information; nor can such an implication be found in the review. Dr. Smith is certainly entitled to the full credit of independent work. The complaint was rather that it was *too* independent (witness the allegation, "at no time have I . . . . had any desire to know what he [Russell] was doing"); and we can see no explanation of the studious avoidance of any reference to the antecedent and contemporary work of Dr. Russell, of which, by his own statement, he *was* "fully cognizant." We leave readers to judge of the validity of the reasons assigned for passing over it in silence. We only remark that, under the circumstances, Dr. Smith had every reason to know that the disease described by Russell, even though imperfectly, was identical with the one he was working upon. Nor does he improve his relation to the matter by magnifying now the errors of that preliminary notice. In newspaper parlance the earlier publication of important information constitutes a "scoop," and in newspaper rivalry, to "scoop" a competitor is not only legitimate, but praiseworthy. It is hardly so regarded in scientific work.— EDS.]

BOTANY AT BROWN UNIVERSITY.

To the Editors of the Botanical Gazette:— I think it is my privilege to correct a wrong impression likely to be conveyed by the recent notice of my *Notebook* in the GAZETTE. Personally I am wholly indifferent to the criticism, but as my university is involved in the charge of erroneous teaching, I feel bound to say a word in her defense.

It is said in the review that a glimpse is here given of the mode of teaching botany at Brown. A glimpse, yes; a comprehensive view, no. My *Notebook* is designed wholly for primary students and has been found to meet its purpose admirably well. Histology and the lower cryptogams,

involving use of compound microscopes and reagents, are thoroughly studied by select students.

As to the point at which a course of botany should begin, opinions differ, and we acknowledge no infallible head to decide the question. East of the Hudson, at least, there are many who agree with us, that while theoretically it is right to begin with the cell, it is impracticable with large undergraduate classes pursuing the course only three hours a week. As to the interest, it is certainly debatable whether the study of morphology is not quite as interesting, and for academic courses as inspiring, as the development of the *punctum vegetationis*. As a matter of fact, so-called "analysis" occupies but a few weeks of our course.— WM. WHITMAN BAILEY, *Brown University*.

[WE ARE sorry that Professor Bailey thinks that "histology" and the "punctum vegetationis" are the only recourse for those who would not begin botany with the "analysis" of spermatophytes. We do not consider it debatable at all as to whether morphology or histology is the more "inspiring" to the beginning student. We agree entirely with Professor Bailey's position in this matter. We only thought that a little less intricate terminology would give more time for morphology, and allow some of the lower forms to come in.—EDS.]

CURRENT LITERATURE.

BOOK REVIEWS.

Nature study.

THE infusion of nature study into our conventional education is like breathing life into a dead body, and yet no subject is in a more chaotic state. It is in danger of being condemned before it has had a fair chance to justify itself. Thrust into the hands of untrained teachers, it has brought to them and their pupils bewilderment and disgust. To give them help, unscientific bookmakers have attempted to organize the subject, and the result has usually been a jumble of ignorance and sentiment. The problem is peculiarly difficult, for it must bring to its solution both experience in teaching children and knowledge of science. Those who have the former qualification have been alone in trying to solve the problem, and have thus far made a conspicuous failure. Those who have only some knowledge of science would be very apt to make an equally conspicuous failure. At least they seem to know enough not to attempt it. Not only is scientific knowledge demanded, but a first-hand knowledge of almost all sciences, and this would naturally cause all but the unscientific to shrink from the task. A book[1] has just appeared which announces the principles of nature study, so far as plants are concerned, with the truest insight. Nothing could be better than the following statements: "Function should precede form;" "It is not important at all to know that the root is fibrous, nor even that the ovate leaves are palmately veined, with a sinuate tooth margin, and are alternately arranged on the stem;" "As a general rule systematic observation defeats its object and stultifies the perceptions of the children; therefore, the main thing should be to keep the *life* side before them."

This certainly rings true, but unfortunately, these excellent ideas do not become embodied in the exercises suggested. Not only are schools afflicted with a conventional education which nature study seeks to vitalize, but there is also a conventional form of botanical instruction which by no means "keeps the life side" before the pupil. Our author knows what she wants, but has not been able to escape the conventional botany. There are a few exercises with leaves which serve to hint at their life relations, and this is

[1] WILSON, MRS. L. L.— Nature study in elementary schools. Small 8vo. pp. xix + 262. The Macmillan Company: New York. 1898. 90 cents.

about all. Even the exercises in seed germination, as usual, call attention to the non-essentials and miss the large facts. As for the bulk of the work, it is the usual round of taking up plant after plant and observing its structural side, not its "life side." There is some interesting non-scientific information about plants, but this seems to be in order to arouse a factitious interest in an otherwise dull task. Even at the beginning of the second year, the direction is to "teach the names of the floral parts — calyx (sepals), corolla (petals), stamens, pistil — and their uses."

We are told that "in the paragraphs marked 'Facts' such necessary knowledge on the subjects therein treated" is given as the teacher is expected to possess; and also "these facts are accurate and based upon the latest and most eminent authority," an expression which makes one shudder when nature study is designed to banish the book and to break the shackles of "authority." In looking over these "facts" it becomes evident that too many of them have been taken from "eminent authority" rather than from observation.

The statement that "the course here presented does not presuppose special training on the part of the teacher" presents a heresy which cannot be too vigorously denounced. It is further stated that "it is not my intention to disparage the value to the teacher of special training in science. Nevertheless, it may be safely stated that the courses generally pursued in college and university do not necessarily equip the student for practical everyday work with little children. They need to be supplemented by actual experience," chief of which, we venture to say, is experience with the subject. Wooden teaching by those who are not trained in a subject is nowhere so conspicuously a failure as in nature study, where the greatest flexibility in the use of material is absolutely necessary.

The book before us is fuller of good intention than any guide to nature study that we have seen; but it will take a good deal of training in the "life side" of plants to enable one to carry out the intention.— J. M. C.

MINOR NOTICES.

MR. JAMES M. MACOUN has published another one of his "Contributions to Canadian Botany."[2] It reports plants new to Canada, new stations and changes in nomenclature.— J. M. C.

MR. EDWIN B. ULINE has published the first part of a monograph of the Dioscoreaceæ[3] as his doctor's thesis at the University of Berlin. The part is devoted to morphology, especially in its relation to the classification of the group, and necessarily involves considerable compilation, accompanied by

[2] Reprint from Canadian Record of Science 267–286. 1897.

[3] Eine Monographie der Dioscoreaceen, Leipzig, Wilhelm Engelmann, Dec. 1897.

discussion of the systematic value of organs. A constancy in the direction of stem twisting, whose importance in classification has been worked out by the author, proves invaluable as a group character, while the importance of characters derived from tuber, rootstock, etc., seem to have been much overestimated heretofore. *Testudinaria* Salisb. has been reduced to a subgenus of Dioscorea, this south African genus having been based upon its tessellated aerial rootstock. The same rootstock was found on the Mexican *Dioscorea macrostachya*.

The following classification is made of the "edible" tubers of the family:

1. Root structure: character uniform.

2. Stem structure: *a*. growth directed downward, subterranean; *b*. growth directed laterally, subterranean; *c*. growth directed upward, above ground.

The striking external differences in *a*, *b*, and *c* are the outcome of variation in the relative position of the most active cambium, and this activity expresses itself quite independently of genetic relationship.

Grisebach and Kunth based their system for the family chiefly upon the character of the staminate flowers, having had but few pistillate plants to examine. The result was that staminate and pistillate plants belonging together were usually described as separate species, and *vice versa*. This arrangement has been very largely abandoned by Dr. Uline, whose exhaustive study of larger and later collections has enabled him to clear away many of the difficulties.

An undescribed kind of hydathode has been found on the leaves of certain African species, and is briefly described.

The chapter "Das System" is but a forecast of the unpublished systematic part, while that on "Geographie" is of unusual value on account of the new perspective, and on account of the exceptionally thorough representation afforded by the material studied. — J. M. C.

A BULLETIN by Dr. H. L. Russell of the Agricultural Experiment Station of the University of Wisconsin, entitled "A bacterial rot of cabbage and allied plants," has recently come from the press.[4] In it is given an account of the origin, symptoms, mode of transmission, and geographical distribution of a bacterial disease which for a number of years has been doing great damage to cabbage and allied plants in various parts of the United States. The morphological, physiological, and culture characters of the organism producing it have been carefully worked out by Mr. H. A. Harding, who has been assisting Dr. Russell.

This is the same disease upon which Dr. E. F. Smith last year published a paper, noticed in this volume, p. 67, and upon which later he issued a Farmer's Bulletin (no. 68) of the U. S. Department of Agriculture. The two

[4] No. 65. February 1898. pp. 39. figs. 15.

investigators agree in almost every particular regarding the disease, so that the main facts may be considered as thoroughly established, having been worked out independently by two competent observers.

It is rather unfortunate, however, that time should be spent in duplicating work, when there is so much to be done. In this particular case, certainly courtesy, not to say economy, demanded that investigation of the disease should not be assumed by the national department, but rather that the work should be left in the hands of the state experiment station, which had a thoroughly trained observer already engaged upon it. In 1895 Dr. Russell presented to the Springfield meeting of the A. A. A. S. a brief preliminary note on "A leaf rot of cabbage," for the purpose of eliciting information in regard to the disease. In this he alludes to certain striking symptoms which serve to identify the disease. His studies were continued in 1896, in the autumn of which year Dr. Smith began his investigation. Scarcely had he begun when he knew Dr. Russell was not only continuing his studies, but had been appealed to by the cabbage growers of Racine, Wis., to find out the cause of their serious losses. The material on which Dr. Smith's first studies were based was sent to him from that locality. While there is no civil law which compels the U. S. Department of Agriculture to keep out of, or withdraw even from work previously undertaken by a state experiment station, there is a law of courtesy which demands it, and Dr. Smith would have done well to heed it.—C. R. B.

NOTES FOR STUDENTS.

ITEMS OF TAXONOMIC INTEREST are as follows: Marshall A. Howe[5] has published a revision of the Anthocerotaceæ of North America, containing ten species of Anthoceros (three of which are new), and two species of Notothylas. Six handsome plates accompany the paper. Anna M. Vail[6] has published a revision of the genus Acerates in the United States, recognizing seven species, one of which is new. John K. Small[7] has published twenty-two new species of Eriogonum, and has constructed a new genus (*Acanthoscyphus*) upon the Californian *Oxytheca Parishii* Parry. H. Eggers[8] has published a new genus of Artocarpeæ from Ecuador, naming it *Poulsenia*.—J. M. C.

THE RECENT DISCOVERY of spermatozoids in Cycas and Zamia has given renewed interest to the study of the Cycadaceæ. Dr. D. H. Scott[9] has discovered in the peduncles of Stangeria and some other cycads the same

[5] Bull. Torr. Bot. Club **25**: 1–24. 1898.

[6] Bull. Torr. Bot. Club **25**: 30–39. 1898.

[7] Bull. Torr. Bot. Club **25**: 40–53. 1898.

[8] Bot. Centralbl. **73**: 49. 1898.

[9] The anatomical characters presented by the peduncle of Cycadaceæ. Annals Bot. **11**: 399–420. 1897.

peculiar (mesarch) type of vascular bundle as has long been known to occur in cycad leaves. Mesarch bundles are found in certain fossils of cycadean stock (Bennettiteæ, Medulloseæ), in the leaves of Cordaiteæ, which like recent cycads had normal stem bundles, and in Lyginodendron and Poroxylon. Dr. Scott's discovery establishes a new link between the Cycadaceæ and the Lyginodendreæ and, coupled with the occurrence of mesarch bundles in these palæozoic plants, makes it probable that this kind of bundle formerly occurred in the stems as well as leaves of cycads. He thinks the loss has been due to the early and increasing development of secondary tissues from the cambium.

Mr. W. H. Lang[10] has investigated the microsporangia of *Stangeria paradoxa*. The nearly mature sporangium has a wall five or six cell-layers in thickness, and the spore mother cells are immediately invested by three differentiated layers. The inner layer is the tapetum, which is not distinguishable till the sporangium is well grown, and then arises from the sporogenous mass. The other two specialized layers are derived from the sporangium wall and consist of flattened cells. The archesporium was not traceable to a single cell, but was a plate of four cells derived by a periclinal division of four large hypodermal cells.—W. R. SMITH.

THE RADICAL DIFFERENCE of opinion regarding bacterial structure which at present exists among investigators who, like Bütschli and Fischer, are most conversant with the subject-matter, naturally makes all interpretations of the observed facts appear more or less in the light of *obiter dicta*, and one of the latest contributions[11] to this interesting discussion can hardly escape being placed in the same category with the others. Meyer, nevertheless, brings to the problem a far richer contribution of fact than is contained in some of the recent polemical deliverances.

A large bacterium (regarded by Meyer as a new species, and named *Astasia asterospora*), which was found upon boiled carrot, afforded especially favorable material for investigation, and the author claims that the use of very high magnifications, combined with carefully chosen illumination, greatly facilitated his study. The spore of Astasia germinates under certain conditions in about six hours, and gives birth to a motile rod which divides and subdivides into new motile forms. After about twelve hours some of these motile individuals come to rest, secrete a gelatinous envelope, and become quiescent, although continuing to divide. Some, but not all, of these rods in the quiescent stage become sporangia, as Meyer terms them, and each

[10] Studies in the development and morphology of cycadean sporangia. Annals Bot. **11**: 421–438. 1897.

[11] ARTHUR MEYER. Studien über die Morphologie und Entwickelungsgeschichte der Bacterien, ausgeführt an *Astasia asterospora* A. M. und *B. tumescens* Zopf. Flora **84**: 185–248. 1897.

sporangium forms one true endospore. The cylindrical spores present a somewhat complicated structure: a two-layered membrane exists, the yellowish outer layer (exine) being raised into ten ridges which traverse the long axis. Viewed from the end the spore is star-shaped. The motile rods that come from the spores possess tufts of flagella, the small cells having but one tuft and the larger never more than from two to four. The individual flagella composing the tufts are exceedingly fine and delicate. These bunches of cilia are never found at the pole, but are always on the side of the cell, and are usually disposed asymmetrically. Meyer would found a new subfamily and genus (Astasia) upon this curious one-sided arrangement of ciliary tufts.

In nearly all stages of development, structures which Meyer regards as nuclei may be revealed by certain methods of staining. A staining solution that gave particular satisfaction was employed after fixation with osmic acid vapor, and was prepared as follows: 0.02^{gr} ruthenium red, 6^{cc} water, 2^{cc} of 95 per cent. alcohol. The coloration obtained with this solution is permanent in glycerin and glycerin-gelatin, but does not hold in Canada balsam. With this method each cell shows one to two and rarely three to four deeply stained granular structures. Other nuclear stains were used with similar results, and Meyer looks upon the granules reacting to these stains as true nuclear substances. He rejects the view that bacteria are undifferentiated "protoplasts" or "archiplasts," as well as Bütschli's conception that the bacterial cell is chiefly nuclear substance surrounded by a mere fringe of cytoplasm.

A study of *B. tumescens* convinced Meyer that the process of spore formation occurs in this species in the same fashion as in Astasia and not in accordance with the statements of earlier workers. He is inclined to extend his observations upon these two species to a generalization covering the whole group of bacteria, and to believe that this method of spore-formation indicates close relationship of the bacteria to the Ascomycetes.—E. O. JORDAN.

MR. W. L. BRAY has recently published a short paper on the geographical distribution of the Frankeniaceæ, considered in connection with their systematic relationships.[12] This paper follows along the line of Engler's studies on the Rutaceæ,[13] and aims to correlate the facts of taxonomy with those of ecology and plant geography. The Frankenias are a small family of plants of extreme halo-xerophytic character and are found in nearly all salt steppes scattered all over the globe, and are always halophytic; hence they are peculiarly well adapted for a study in ecological phylogeny. The various species are taken up in detail by geographic regions, viz., the Mediterranean region, South Africa, Australia, South America, western North America and several oceanic islands. Australia, South America and the Mediterranean district

[12] Eng. Bot. Jahrb. **24**: 395–417. 1897. [13] See BOT. GAZ. **23**: 220. 1897.

are the three large centers of development. The author divides the family into two groups, one of which includes nearly related forms occurring in most salt steppes, and the other including a large number of monotypic forms in isolated locations, and sharply distinct from each other, the remnants of a previous development. The character of the first group requires the supposition of migration within rather recent times, and the original center was probably Australia or the Mediterranean region, the American forms having come from Australia. A southern extratropical origin seems most likely. The means of dispersal is not clear, since the seeds are not adapted for flotation nor for clinging to objects, such as birds. The character of the second group leads Mr. Bray to the idea that the isolated forms are relics of a far wider distribution in the past, when there were, perhaps, much more extensive halophytic areas than exist today.—H. C. COWLES.

CONTINUING THE WORK of Kny, Mr. C. O. Townsend [14] has completed a series of experiments at Leipzig in the Pfeffer laboratory, whose results throw new light upon the precise effect of injury upon growth. The study was limited to seed plants, excepting a number of experiments upon *Phycomyces nitens*. Cuttings and introduction into an atmosphere of ether were the injuries employed. The fully tabulated results definitely establish that slight injury to root or shoot promptly accelerates the rate of growth, while, as the severity of the injury is increased, the acceleration becomes preceded by a varying period of retardation. In seed plants the minimum "latent period" observed was six hours, but in Phycomyces injury to the mycelium produced almost immediate retardation of the growth of the sporangia stalks, the normal rate being restored in from thirty to sixty minutes. Such irritation was found to act through distances up to 260 mm, slight injuries to the root tips becoming soon apparent in changing the rate in the growing zone of the stem. The change may vary from the normal rate by 0 to 70 per cent., but only the most general results could be foretold from a specified injury; largely, of course, because the influence of turgor could not be eliminated.—J. G. COULTER.

A. PREDA [15] has recently investigated the embryo sac of several Narcissus forms, some of which were hybrids. In the hybrids various degrees of reduction were noted. Sometimes there was a small sac with egg apparatus and endosperm nucleus, often there was no trace of a sac, and in some cases not even the ovules were developed.

In referring to chromatophily the author quotes Auerbach, who would make the terms cyanophilous and erythrophilous almost synonymous with

[14] The correlation of growth under the influence of injuries. Annals of Botany 11: 509–532. 1897.

[15] Recherches sur le sac embryonnaire de quelque Narcissées. Bulletin L'Herb. Boiss. 5: 948–952. 1897.

male and female; Strasburger, who makes the erythrophilous or cyanophilous condition depend upon abundant and impoverished nutrition respectively; and Zacharias, who says that the reaction depends upon the amount of phosphorus present in the nucleus, the nuclei rich in phosphorus being cyanophilous. He says that Zacharias' theory does not agree with Strasburger's, and also quotes Rosen's researches upon meristem as contradicting the nutrition theory. The author claims that the reactions in Narcissus are also at variance with Strasburger's views. It seems to us that the usual embryo sacs at least afford no contradiction to Strasburger's theory, and from the description Narcissus does not appear to be any exception to the rule. The fusion of polar nuclei is regarded as an act of fertilization and the endosperm as a new plant.

The author killed his material in alcohol, and though he imbedded it in paraffin, he preferred the ordinary razor to the microtome.—C. J. CHAMBERLAIN.

WÄCHTER has been carrying on experimental studies on water plants with a view to making clearer our knowledge of the relations existing between leaf form and external conditions.[16] Goebel's work on similar problems suggested the nature of the experimentation, and the author's results confirm Goebel's previous conclusions quite fully.[17] The first part of the paper treats of the influence of external agents on various monocotyls, especially Sagittaria. It is well known that leaves developed in deep water are narrow, while those developed in shallow water are much broader and often sagittate in some species. Goebel showed that this, like other leaf forms, is a light relation.[18] Wächter conducted all sorts of experiments, producing both types of leaves at will. Plants grown on the land developed broad leaves, while broad-leaved land forms developed narrow leaves when placed in water. Narrow leaves were produced in land forms that were insufficiently nourished, and also where grown in weak light. The author concludes that leaf form is not predetermined, but depends on environment, being fundamentally a matter of nutrition. The second part of the paper is a morphological and anatomical study of Weddelinia, and the third part describes the results of experimental work on Nymphæa, which are quite similar in general character to those described above for monocotyls.—H. C. COWLES.

IT HAS RECENTLY been shown by Professors Babcock and Russell[19] of the University of Wisconsin that the ripening of cheese is partly due, at least, to the presence of proteolytic enzyms, normally contained in milk, whose existence has not before been recognized. Heretofore the changes during the ripening process have been wholly ascribed to the action of bacteria.—J. C. A.

[16] Flora **83**: 367–397; **84**: 343–348. 1897.

[17] See Bot. Zeit. **38**: 752. 1880; Flora **72**: 1. 1889; Biologische Schilderungen, etc.

[18] Flora **80**: 96–116. 1895; **82**: 1–13. 1896.

[19] Centr. f. Bakt. u. Paras. **3**²: 615–620. 1897.

NEWS.

MISS JULIA SNOW, Ph.D. (Zürich) has been appointed Instructor in Botany in the University of Michigan.

MR. JOHN DONNELL SMITH sailed for Europe about the middle of March, expecting to be absent until the middle of October. He will divide his time between Spain and England.

JAMES BATEMAN, whose monumental work on the orchids of Mexico and Guatemala is one of the sights of the great libraries, died November 27, 1897, at his home in Springbank, near London, at the age of 86.

THE NEW *Journal of Applied Microscopy* has begun a series of articles on "Representative American laboratories." The first ones to be described are those of Cornell University, in the February number of the journal.

SIR JOSEPH HOOKER'S great work on the Flora of British India has at last been completed, a work which has been in mind and in hand more or less since 1848, when the author made a botanical investigation of the Himalayas.

DR. JOHN M. COULTER, of the University of Chicago, and Dr. Douglas H. Campbell, of Leland Stanford University, have recently been elected associate fellows in the section of botany of the American Academy of Arts and Sciences, Boston.

WITH THE BEGINNING of the year the *Bulletin of the Torrey Botanical Club* passed under an entirely new editorial management. The organization is as follows: *Editor*, Lucien Marcus Underwood; *Associate editors*, Carlton Clarence Curtis, Byron David Halsted, Arthur Hollick, Marshall Avery Howe, Francis Ernest Lloyd, and Anna Murray Vail.

THE PRICE LISTS of native ornamental plants from the nurseries of Edward Gillett, of Southwick, Mass., and F. H. Horsford, of Charlotte, Vt., have recently come to hand. These dealers, as well as a number of others, offer a surprisingly large number of interesting plants, that are often desirable for illustrative material. If teachers knew how cheaply and easily such plants as Drosera, Dioncœa, Sarracenia, etc., as well as asters, solidagos, ferns, etc., can be obtained, and how little trouble they are to grow in the garden or greenhouse, it is probable that classes would oftener have the opportunity to see the living plants.

DR. CHARLES R. BARNES has been appointed Professor of Plant Physiology in the University of Chicago. His laboratories will be equipped during the summer, and his courses will begin with the autumn quarter. The work of the Hull Botanical Laboratory has been largely morophological heretofore, and it is now proposed to put equal emphasis upon physiology, including ecology.

A STUDY of the ecological plant geography of Kansas has been made by Professor A. S. Hitchcock, and was presented before the Academy of Science of St. Louis at the meeting of February 7. The paper was referred to the council for publication. At the same meeting Professor L. H. Pammel discussed the taxonomic value of the anatomical character of seeds, a study which has engaged his attention for some years past.

THE PAPER on "Bibliographical difficulties in botany," read by Professor Edward L. Greene before the Botanical Society of America at its Toronto meeting, has been distributed as a reprint from the *Catholic University Bulletin* 4: 62–75. 1898. The paper was very briefly summarized in BOTANICAL GAZETTE **24**: 183–185, 1897. It should be read in its complete form by all those who are engaged in determining the real names of plants.

THE EDIBLE and poisonous mushrooms are being studied in regard to their physiological action as food by a commission of the American Physiological Society, consisting of Professors Crittenden (Yale), Abel (Johns Hopkins), Pfaff (Harvard), and Bowditch (Harvard). Their first report was made to the society at its recent meeting in Ithaca, and brought out the statement that the edible fungi do not contain nearly as much digestible proteids as they are usually credited with, and that their food value in this respect has been overrated.

THE FOLLOWING PRIZES for botanical work were awarded by the Académie des Sciences of Paris, at its annual public session January 10: *Prix Desmazières* (1600 fr.) to Professor Jakob Eriksson for observations on the rust of cereals; *Prix Montagne* (1500 fr.) to Professor Bourquelot for his work on the physiology of mushrooms; *Prix Thore* (200 fr.) one-half to M. Sappin-Trouffy for investigations on the development of the Uredineæ; *Prix Gay* (2500 fr.) to Charles Flahault for his study of the geographical distribution of the French Mediterranean flora.

THE NUMBER of persons officially designated as "botanists" or "mycologists," who are at present connected with the agricultural experiment stations of the United States, is fifty, according to a recent government bulletin.[1] Fourteen of these bear in addition the title of horticulturist, entomologist, or chemist; while two have executive duties specified. The full list is as follows:

[1] Organization lists of the agricultural experiment stations and institutions with courses in agriculture in the United States. Bull. 47. Office of Exper. Sta., Wash. Gov. Printing Office, 1898, pp. 96.

State	Name	Official title
Alabama	P. H. Mell, Ph.D.	Bot.
Arizona	J. W. Toumey, B.S.	Bot., Ent., and acting Dir.
California	W. A. Setchell, Ph.D.	Bot.
"	J. B. Davy	Asst. Bot.
Colorado	C. S. Crandall, M.S.	Bot. and Hort.
Connecticut	Wm. C. Sturgis, Ph.D.	Myc.
Delaware	F. D. Chester, M.S.	Myc.
Idaho	L. F. Henderson	Bot.
Illinois	T. J. Burrill, Ph.D.	Bot. and Hort.
"	G. P. Clinton, M.S.	Bot.
Indiana	J. C. Arthur, D. Sc.	Bot.
"	William Stuart, B.S.	Asst. Bot.
Iowa	L. H. Pammel, M.S.	Bot.
"	C. R. Ball, B.S.	Asst. Bot.
"	Robt. Combs, B.S.	Asst. Bot.
Kansas	A. S. Hitchcock, M.S.	Bot.
"	Geo. L. Clothier, B.S.	Asst. Bot.
Kentucky	H. Garman	Bot. and Ent.
Louisiana	W. R. Dodson, M.A.	Bot.
Maine	F. L. Harvey, Ph.D.	Bot. and Ent.
Massachusetts	Geo. E. Stone, Ph.D.	Bot.
"	Ralph E. Smith, B.S.	Asst. Bot.
Michigan	C. F. Wheeler, B.S.	Consulting Bot.
Minnesota	Otto Lugger, Ph.D.	Bot. and Ent.
Mississippi	G. W. Herrick, B.S.	Bot. and Ent.
"	J. S. Moore, M.S.	Asst. Bot.
Missouri	C. H. Thompson, B.S.	Asst. Bot.
Montana	H. S. Jennings, Ph.D.	Bot.
Nebraska	C. E. Bessey, Ph.D.	Bot.
Nevada	F. H. Hillman, M.S.	Bot. and Ent.
New Jersey	B. D. Halsted, D.Sc.	Bot. and Hort.
New York (Cornell)	G. F. Atkinson, Ph.B.	Bot.
" "	B. M. Duggar, M.S.	Asst. Crypt. Bot.
" (Geneva)	F. C. Stewart, M.S.	Myc.
North Carolina	C. W. Hyams	Asst. Bot.
North Dakota	H. L. Bolley, M.S.	Bot.
"	Merton Field, B.S.	Asst. Bot.
Ohio	A. D. Selby, B.S.	Bot. and Chem.
Oklahoma	E. E. Bogue, M.S.	Bot. and Ent.
Oregon	Moses Craig, M.S.	Bot.
Pennsylvania	W. A. Buckhout, M.S.	Bot.
South Carolina	A. P. Anderson, Ph.D.	Bot.
South Dakota	De Alton Saunders, M. A.	Bot.
Tennessee	S. M. Bain, B.A.	Bot.
Utah	U. P. Hedrick, M.S.	Bot. & Hort.
Vermont	L. R. Jones, Ph.B.	Bot.
"	W. A. Orton, B.S.	Asst. Bot.
Virginia	W. B. Alwood	Myc., Hort., Ent. and Vice Dir.
Washington	C. V. Piper, M.S.	Bot. and Ent.
Wyoming	Aven Nelson, M.S.	Bot.

There are now fifty-one state experiment stations, one to each state of the list, except Connecticut and New York, which have two each. One of the Connecticut stations employs no botanist, and ten other state stations are also without botanists, viz.: Arkansas, Florida, Georgia, Maryland, New Hampshire, New Mexico, Rhode Island, Texas, West Virginia, and Wisconsin. It is presumable, however, that in some cases, and it may be in all, botanical work is carried on by other members of the staff, especially by the horticulturist, biologist or bacteriologist, when such officers are named. In some cases where botany is associated with horticulture or entomology, it is either largely neglected, or receives the greater share of attention, for the subjects are too large to be successfully combined, so that a few names on this list represent but nominal botanists. Yet there are recognized botanists not on the list, like Professor Rolfs of the Florida station, and Dr. Russell of the Wisconsin station, who offset such defection.

A corps of fifty trained botanists, scattered over the breadth of the land should accomplish great good both for agricultural practice and for pure science.

THE VERMONT BOTANICAL CLUB held its third annual meeting at the University of Vermont, February 4 and 5. Among the titles we note the following: Recent tendencies to recognize new species, *President Ezra Brainerd;* Dissemination of plants due to seed structure rather than number, *Miss B. C. Verder;* Among the ferns, *Rev. J. A. Bates;* Notes from field and herbarium, *Mrs. A. J. Grout, Carleton D. Howe, Dr. G. H. Perkins,* and *Professor L. R. Jones;* Common notions of physiological constants, *Professor F. A. Waugh;* On collecting and preparing fleshy fungi for the herbarium, *Dr. E. A. Burt;* Vermont myxomycetes, *Miss F. M. Sutton,* and *Miss L. C. Whitney;* Vermont hepatics, *Clifton D. Howe.*